1989

An investigation of trends and issues of technology education

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Order Number 9014924

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Iowa State University, 1989

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An investigation of trends and issues of technology education

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A Dissertation Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major: Industrial Education and Technology

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1989

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CHAPTER I. INTRODUCTION

With the rapid growth of science, western civilization is undergoing a dramatic technological revolution. Actually, this unprecedented technology change in human history began in the latter portion of the twentieth century. Naisbitt (1982) observed that scientific and technical information increases thirteen percent per year, which means it doubles every five and one-half years. Naisbitt emphasizes that with the advent of an information society, we have, for the first time, an economy based on a key resource that is not only renewable, but also self-generating. This means high school freshmen of 1988 will experience a quantum leap in the volume of information by the time they graduate four years later. The educational system needs a means of coping with this situation. Coping with the rapid technological change is the greatest challenge that educators face.

The impact of technology within our society has placed education at a crossroads. Many subject areas are being forced to change direction, due to this technological impact and the effect it will have on the youth of our nation within the next decade (Andre & Lucy, 1985). As a widely established technology instruction course in our school systems, technology education/industrial arts is responsible for providing students with technological literacy which is essential for being effective citizens in an advanced technological society.

Throughout the history of what is currently called the technology education movement, there has been a continuing debate on the nature of its content and an appropriately descriptive name for this field. The early leaders advocated such titles as manual training, Sloyd, manual arts, and industrial arts (Luetkemeyer, 1984). The term manual training was generally used after about 1876; manual arts appeared and drew support beginning about 1894; and industrial arts began finding acceptance after about 1910 (Barlow, 1967). Each change suggested some sort of growth or evolution in content with changes in practices. Manual training established manipulative skill development as the key element in the early programs. Manual arts introduced project making with increased emphasis on creativity and improved design to previous manual training. Industrial arts added elements and organization of industry (Bender, 1982). The current debate within the field focuses on the shift of instruction to technology (Ritz, 1981; Wright, 1980) and subsequent change of industrial arts to technology education (McCrory, 1980).

The idea of using technology as a potential source of teaching content originated with Frederick Bonser, but it was William Warner who brought this viewpoint to national attention. Warner introduced the New Industrial Arts Curriculum at the 1947 American Industrial Arts Association Conference, curriculum which was intended to reflect technology and which was basically an extension and modification of his Laboratories of Industries of the 1930s (Warner, 1965). It was Delmar Olson (1958), two decades later, however, who brought more form to Warner's nascent ideas through the publication of "Technology and Industrial Arts", in which he identified curricular components representative of technology. Olson's work, along with that of Paul DeVore (1968), Henry Ziel (1971), and others, led to the search for a broader content base for industrial arts, one that would encompass a study of technology. This search has occupied many in the profession for the past decades (Herschback, 1984).

The movement of technology education gained its momentum as recently as the 1980s. The impetus for this movement was generated by a number of important contemporary developments such as numerous commission reports on education; technology's impact on society; transition from an industrial to a post-industrial society to an information age; new high school graduation requirements; increased emphasis on basics, mathematics and sciences; and a need to strengthen the profession's role in public schools (Maley, 1987b). Starkweather (1986) also observed that the change from industrial arts to technology education resulted in three major developments: the tremendous amount of curriculum development completed in the 1960s; the Jackson's Mill curriculum document in 1979, which served as a foundation for much of the thought that has followed; and the many reports examining the status of education in the United States.

The overriding objective of technology education is literacy, technological literacy for all citizens (American Industrial Arts Association, 1983; DeVore, 1987; Lux, 1984; Maley, 1987b; Moss, 1987; Sterry, 1987). Technological literacy means that a student must understand basic scientific concepts; know societal needs and moral constraints; be cognizant of the application of scientific principles to tools and materials; and, to a certain extent, be able to utilize these tools and materials (Waetjen, 1987). The need for technological literacy education in the public schools has been addressed by numerous national reports on education innovative curricula and several publications (Boyer, 1983; Buchen, 1980; Friedman, 1980;

Murchland, 1982; Lisensky, 1985; The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, 1983; Waetjen, 1987).

To cope with the need for preparing youth to function effectively in a technological, participatory society of the future, several vital efforts including curriculum restructuring, name change, professional improvement plan, and improving public relations have been initiated by the industrial arts profession. The technology education movement brings many opportunities and potentials to the profession. Maley (1987a) stressed that the opportunities that the profession has in its move from industrial arts to technology education are, in many respects, unlimited. The limitations are defined purely by the ingenuity and imagination of the profession, its teachers, administrators, and leaders. Starkweather (1986) also emphasized that seldom have the opportunities been greater for technology educators to make an impact on the field of education. He further indicated that the time has come to create a strong interface with the National Science Foundation, the American Association for the Advancement of Science, and numerous other groups, such as those in engineering, who support the preparation of technologically literate individuals who can make an important contribution to society.

Despite the optimistic assessments for the technology education movement given by the professional leaders, a number of studies have been conducted to investigate the problems that the technology education movement has experienced or inherited from its precursor - industrial arts (Feirer, 1984; Maley, 1987a, 1987b; Starkweather, 1986; Lauda & McCrory, 1986; Edmunds, 1980; Zook, 1976; Miller, 1978; Dunathan, 1979; Schoonmaker, 1984; Herschback, 1984; Swanson, 1983; Webb, 1976; Conley, 1978; Sharpe & Householder, 1984; McMurry, 1980). These studies revealed that the serious problems which could hinder the technology education movement include the debate over the philosophical base of technology education (Swanson, 1981, 1983; Lauda, 1982), severe shortage of industrial technology teachers (Edmunds, 1980; Zook, 1976; Miller, 1978; Sharpe & Householder, 1984; Dunathan, 1979), enrollment decline of technology education classes in secondary schools (Schoonmaker, 1984; Maley, 1987a, 1987b), closing of technology education teacher training programs in universities (Savage, 1985), lack of a well-defined content base (Herschback, 1984; Swanson, 1983), a marked difference between the knowledge and study and the actual activity and result (Herschback, 1984), outdated laboratories (Lauda & McCrory, 1986), and competition for student sources with industrial technology programs (McMurry, 1980; Webb, 1976; Conley, 1978).

The possible directions and remedies for solving technology education problems have been eagerly pursued by those concerned with the development of the technology education movement. Some feasible strategies suggested in the literature include: employ more effective recruitment techniques in technology education teacher preparation programs (Savage, 1985; Edmunds, 1980; Sharpe & Householder, 1984), upgrade teacher education programs, strengthen the foundation for technology education, develop new/improved instructional delivery systems, expand curriculum resources, enhance the expertise of personnel (Starkweather, 1986), improve public awareness and support, increase personal commitment to the profession, develop and improve model technology education programs (Maley, 1987a; Starkweather, 1986), improve technology education image among secondary school students, recruit female students, offer flexible schedules, and improve the ambiance of laboratory facilities (Schoonmaker, 1984).

Concern and speculation have become the theme of a great number of journal articles, editorials, special publications, speeches, and forums as a result of the current technology education movement. However, there has been only a limited number of empirical studies and activities associated with these endeavors. Further investigations on the impact of the movement upon the common practices in the profession are scarce. What are the philosophical missions for technology education? What serious problems are plaguing technology education programs? What are the possible directions the technology education profession should take for improving technology education programs? And what are the present status and the future prospects of technology education programs? These questions are worth further investigation.

Statement of the Problem

This study was designed to investigate the trends and issues confronting technology education movement. It also examines selected variables in order to determine if they contribute to the perception of philosophical objectives, problems, solutions of problems, and the present status and prospects of technology education programs. A proposal for program frameworks and implementation suggestions are also examined.

Purpose of the Study

The purpose of this study was to examine the nature of the current technology education movement and its impacts, problems, and directions, as well as prospects for the technology education profession.

More specifically, the purposes of this study were:

1. to examine the philosophical base of technology education.
2. to ascertain the developing trends of technology education teacher training programs in respect to enrollment, curriculum emphasis, program type, employment trends, graduates' salary, faculty specialty, impact of technology to TE program, and adaptation of technology.
3. to investigate the problems confronting technology education programs pertaining to teacher factor, enrollment factor, teaching-content factor, and facility factor.
4. to ascertain possible directions the technology education profession should take for solving the problems that are currently plaguing the discipline.
5. to examine the prospects of the technology programs with respect to enrollment trends, teacher demands, teacher salary, profession image, program quality, and facility.
6. to determine if significant correlations exist between selected variables such as program type, highest degree offered, enrollment trends, employment

trends, curriculum emphasis, and impact of technology, as well as adaptation of technology and the following variables: perception of philosophical objectives, problems, solutions to problems, present status, and prospects of technology education programs.

7. to provide educators and administrators in the technology education programs with information which would be helpful in improving their programs.

Significance of the Study

In recent years, there has been an increasing concern over the impact of technology on our daily life and the role of technology in the future. The public and governmental decision-makers are gradually realizing that levels of technological understanding are greater than ever to enable the citizens to participate effectively in decision-making, regarding technological alternatives in the solution of problems. Abundant advocacy consistently calls for a form of technological literacy demanded of most people in public schools. What schools can do to develop in the citizenry a reasonable degree of technological literacy is the pressing problem that requires our best thinking and perhaps a movement into new and different forms of content involvement (Maley, 1987b). Thus technology education, a well-established instruction course in the school systems, inevitably is responsible for establishing some form of direction and focus for the program and examining the interface between technology and the disciplines of science and mathematics as a fundamental curriculum framework.

The transition from industrial arts to technology education brings enormous challenges to the profession. To manage the process of this change, the profession must create solutions to resolve discrepancies between the programs and philosophies of technology education and current practices, redefine content direction to improve the public's perception and understanding of technology education, research and develop new/improved instructional delivery systems, provide laboratory planning and equipment selection to facilitate implementation of the new content and methodologies, and improve the quality of teacher education programs. Extensive research efforts are needed to justify these directions.

This study is designed mainly to investigate the nature of the technology education movement and its impacts, problems, and directions, as well as prospects for the technology education profession. It is believed that the information and findings of this study will contribute to a better understanding of the characteristics, status, and thrust of technology education which are currently evolving.

Hence, this will help educators and administrators modify their program and instruction and improve the learning environment.

Questions of the Study

This study addressed the following research questions:

1. What were the philosophical missions for technology education in the public schools? Were there significant differences in philosophical objectives of technology education perceived by chairpersons in the three department types?
2. What serious problems were plaguing technology education programs in secondary schools and in colleges or universities? Were there significant differences among the three survey groups in these problem issues?
3. What were the possible directions the technology education profession should take for improving technology education programs? Did the responses from the three survey groups differ significantly in these respects?
4. What were the present status and the future prospects of the technology education programs with respect to enrollment trends, curriculum emphasis, facility and equipment planning, and teacher factors? Were there

significant differences among the three survey groups in the perception of present status and prospects of technology education programs?

5. Did the selected variables such as highest degree offered, enrollment trends, type of graduates' employment, faculty specialty, perception of technology impact, adaptation of new technology into curriculum, and curriculum emphasis contribute to the perception of philosophical objectives, problems, solutions, and the present status as well as future prospect of technology education programs?

Procedure of the Study

The procedure of the study consisted of the following:

1. Review and synthesize existing industrial arts and technology education literature to obtain vital information pertaining to developing trends and issues in industrial arts and technology education.
2. Identify this study's population. The faculty of industrial arts/technology education departments at the college level were identified as the population for this study.
3. Select a sample from the population. The chair-persons were identified and selected as the sample from the "Industrial Teacher Education Directory".

4. Develop a survey form which contains items for answering research questions and hypotheses.
5. Verify content validity, plausibility of items, and the appropriateness of constructed questionnaire items.
6. Revise questionnaire items based on the suggestions from the validity test.
7. Collect data. The survey questionnaire was mailed to 212 research subjects, and follow-up letters were sent to nonrespondents.
8. Code subjects' data for computer processing.
9. Draw conclusions based on the results of the data analysis.
10. Report research results.

Assumptions of the Study

The following assumptions were made concerning this study:

1. The survey questionnaire administered to the research subjects to investigate the emerging trends, issues, and prospects of industrial arts/technology education was valid for that purpose.
2. The procedures for selecting the research subjects were valid and adequate for making inferences to the general population.

3. The participants gave honest responses to the items of the questionnaire.
4. The subjects were able to interpret correctly the questionnaire items.
5. Any uncontrolled variables of the study were uniformly distributed over the entire sample.

Limitations of the Study

This study was conducted under the following limitations:

1. Generalization of this study was limited to the industrial arts/technology education programs at the college level.
2. The research subjects of this study were limited to the chairpersons of the industrial arts/technology education departments at the college level.

CHAPTER II. REVIEW OF LITERATURE

In this chapter, literature pertaining to the industrial arts/technology education are examined and presented in four sections: (1) historical perspective, (2) philosophical views, (3) teaching contents and strategies, and (4) problems and directions.

Historical Perspective

Manual training

The roots of industrial education reach deep into the history of civilization. One can only guess as to when such efforts began to take place on a formal basis, for they developed slowly from generation to generation (Cochran, 1970). The recorded history of what is today known as industrial arts/technology education began in the public schools in the United States in 1883 (Bennett, 1937). It was called manual training. Manual training at that time was considered both general and vocational. The primary emphasis, however, was on vocational training (Minnesota Department of Education, 1962). Woodwork, drawing, forging, and metal work were the fundamental manual training subjects. In the ten years from 1883 to 1893, manual training was introduced into public high schools in more than fifty cities in the United States. By 1900, this number had more than doubled (Bennett, 1937).

Manual arts movement

Under the influence of the Russian and sloyd systems, early industrial education practitioners developed many curricular variations. By far the most dominant force of that era, however, was the manual arts movement. This grew out of a concern over the lack of aesthetics and correlated design instruction in manual training programs. Such programs focused on creative design as an integral phase of instruction and called for the use of models, discussions, and individual assignments to produce more beautiful objects and art-craft products. While the term manual arts was first introduced during the 1890s, it was not until the turn of the century that it had a marked influence on the profession. Support for manual arts programs, which emphasized technical skills and sensitivity to form and functions, spread rapidly throughout the United States and began to outstrip its counterpart manual training. Founded in 1909, the Mississippi Valley Manual Arts Conference was the central coordinating agent and provided national leadership for the entire movement (Cochran, 1970).

Industrial arts movement

The manual arts movement remained the dominant force well into the 1930s. However, impetus provided by Richards, Bonser, Dewey, and others caused some industrial educators to experiment in other directions. As early as 1904, Richard suggested that the term "industrial arts" be substituted for the term "manual training" because the scope of manual training was nothing short of the elements of the industrial fundamental to modern civilization (Bennett, 1937). In 1909, Russell advocated a course in industrial arts dealing with stages of production, distribution, and consumption of such raw materials as foods, metals, textiles, and woods (Cochran, 1970). In an attempt to expand upon the idea of providing a better perspective of man's achievement, Frederick Bonser and Lois Mossman emphasized that industrial arts should be concerned with the changes made by man to materials to increase their value for human use (Bonser & Mossman, 1923).

The general shop organization was a second departure from one-activity shops of manual training. Under such an arrangement, the students participated in various activities with a variety of tools, equipment, and materials. During 1906 to 1917, several industrial educators such as Frederick Bonser at State Teachers College, Macomb, Illinois, George Buxton at The Stout Institute in Menomonie, Wisconsin, and John Trybom in the Detroit Public Schools began to experiment with the idea of teaching more than one activity at the same time with the general shop organization in the classroom (Cochran, 1970).

Curriculum innovation in the sixties

Industrial education has been in a constant state of change in the United States since its early inception in the secondary schools. Industrial educators in the sixties produced more modifications with wider implications than did any of the preceding decades. To make education relevant--relevant in the sense of content, teaching methods, and in relation to the technological society--was the major focus of this curriculum innovation movement (Cochran, 1970). The impetus of the curriculum innovation was stimulated by the "Sputnik" influence. This movement was further promoted by the technological developments, automation, disappearance of many occupational categories, and other economic factors to focus attention on providing students with a wider range of experiences, programs to meet life's needs, and activities directed at an understanding of contemporary society.

Another important influence on the curriculum innovation during the sixties was research effort sponsored by the the Ford Foundation and federal government agencies. In 1950, the Ford Foundation instituted a program to identify and contribute to the solution of problems of national and international importance. During the early sixties, the Ford Foundation began to focus its attention on research and experimental programs designed to meet the occupational education needs of an advancing technological society. Numerous programs have been funded which attempted to overcome the traditional separation between academic and vocational education. The U. S. Office of Education established two national research centers, Ohio State University and North Carolina State University, to provide a catalytic role in the research, development, and dissemination of research pertinent to the problems in vocational and technical education.

Based upon these influences, at least twenty funded curriculum projects in industrial education were developed through federal, state, and foundation sources during the 1960s. The effort of these curriculum projects was to develop and experiment with innovative plans and programs for a more adequate and accurate presentation of the industrial aspects of society. Robert Swanson (1965) classified these projects into four major groups: integrative programs, occupational family programs, technology-oriented programs, and interpretation of industry programs.

<u>Technology education movement</u>

The concept of technology as a potential source of teaching content for industrial arts originated with Frederick Bonser. William Warner, Delmar Olson, Paul

DeVore, and others brought this idea to the attention of the profession. The term "Technology Education" was first introduced by a group of graduate and postgraduate students at West Virginia University in 1970. Technology education, they decided after careful deliberation, was used to name a program which was designed to help students comprehend their technological inheritance and technological future. Consequently, the first program in the history of the industrial arts profession, at West Virginia University, changed its name to reflect contemporary technology. In the following years, many colleges and universities renamed and restructured their industrial arts education programs to reflect a technology-based orientation (Lauda & McCrory, 1986).

The technology education movement began to gain its wide-spread support in the 1980s with the help from several national reports on education innovation and the Jackson's Mill Industrial Arts Curriculum document. To stress the need for technology education in public schools, The National Science Board's Report on Precollege Education in Mathematics, Science, and Technology (1983) indicated that students must be prepared to understand technological innovation, the productivity of technology, the impact of the products of technology on the quality of life, and the need for critical evaluation of societal matters involving the consequences of technology. The report continued that people must know about technology in order to improve the quality of many personal and professional technology-based decisions. People must understand the limitations as well as the capabilities of emerging technologies. The technologically literate person should have a sense of what technology can and cannot do. He or she should not believe that technology can solve all ills, nor that technology is responsible for most problems.

Ernest Boyer (1983), in "High School: A Report on Secondary Education in America", also provided support for technology education. He stated that we recommend all students study technology: the history of man's use of tools, how science and technology have joined, and the ethical and social issues technology has raised. During this proposed one-semester course, a student might look at one technological advance--telephone, automobile, television, or minicomputer, for example--and trace its development and examine the positive and negative impact it has on our lives today. Another comment on technological literacy by Boyer is that the great urgency is not computer literacy but technological literacy, the need for students to see how society is being reshaped by our inventions, just as the tools of earlier eras changed the course of history. The challenge is not learning how to use the latest piece of hardware, but asking when and why it should be used.

Another force which has significant impact on the technology education movement is the Jackson's Mill Industrial Arts Curriculum Symposium, which spanned the years 1979-81. The symposium was comprised of 21 industrial arts educators who tried to translate the debate about the direction and future of industrial arts into action. They discussed the relationship of industrial arts to comprehensive education and the rededication of industrial arts educators to a common professional cause. In this curriculum document, the technological literacy was clearly identified as the prime objective of industrial arts, and technology and industry as its content source.

In addition, leaders in the profession enthusiastically promoted this new curriculum direction. This effort was followed by many other significant events which altered content and instructional strategies in many programs at all levels. In 1985, the American Industrial Arts Association changed its name to the International Technology Education Association (ITEA). The long-range plan of the ITEA (1986-90) calls attention to the need for technological literacy and sees Technology Education as the discipline to provide such an education (Lauda & McCrory, 1986).

Philosophical Views

The purpose of any educational program reflects the philosophical basis of that program and plays an important foundational role in its development. Since its inception, philosophical views of Industrial Arts (IA)/Technology Education (TE) have been a subject of discussion within the profession in an attempt to clarify, modify, or update existing statements of purpose, or to develop new approaches to IA/TE education (Bame & Miller, 1980).

In this section, the definition of IA/TE and objectives of IA/TE are briefly reviewed.

Definition of IA/TE

Throughout its long history, the definition of Industrial Arts has been constantly modified for meeting the needs of society. A definition, given in 1937 (Minnesota Department of Education, 1950), has been frequently cited and, to some extent, is still appropriate today. Industrial arts is a phase of general education that concerns itself with the materials, processes, and products of manufacture, and with the contribution of those engaged in industry. Learning comes through the pupil's experiences with tools and materials and through the study of resultant conditions of life. It is a curriculum area rather than a subject or course, comparable in this respect to the language arts.

Wilbur (1948) was one of the first educators to devise and publish a comprehensive definition of industrial arts education. He defined IA as "those phases of general education that deal with industry--its evolution, organization, materials, occupations, processes, and products--and with the problems resulting from the industrial and technological nature of society."

More recently, in a document used to brief the nation's congressional representatives on industrial arts' potential, the American Industrial Arts Association (AIAA, 1976) defined IA as those education programs which pertain to the body of related subject matter, or related courses, organized for the development of understanding the technical, consumer, occupational, recreational, organizational, managerial, social, historical, and cultural aspects of industry and technology, including learning experiences involving activities such as experimenting, designing, constructing, evaluating, and using tools, machines, materials, and processes which provide opportunities for creativity and problem-solving and assisting individuals in the making informed and meaningful occupational choices.

As technology expanded at an exponential rate, technology became the dominant theme and replaced the basic concept of industry. Maley (1973) recognized the need to create such a definition, while maintaining an industrial base. He defined industrial arts education as those phases of general education which deal with the evolution, utilization, and significance of the technology and with the organization, materials, occupations, processes, and product of the industry, and with the problems and benefits resulting from the technological and industrial nature of society.

The most recent definition was the outcome of the Jackson's Mill Industrial Arts Curriculum Symposium (Hales & Snyder, 1982). The symposium stated that Industrial Arts is a comprehensive educational program concerned with the evolution, utilization, and significance of technology; and the organization, personnel, systems, techniques, resources, and products, and other social/cultural impacts of industry. This definition suggested that the industrial arts profession must move from an exclusive focus on the standard technical areas (wood, metal, graphics, etc.) or on industry (tools, materials, processes) to the inclusion of a broader focus on technology in both its technical and socio/cultural elements (Sullivan, 1987). The reference to industrial arts as being a comprehensive education program is the main difference from Maley's definition. Others have stated that if the term "industry" is broadened to include service occupations such as radio and television repair, allied health field, auto servicing, etc., the scope of industrial arts education becomes more global--encompassing practically all organized economic, industrial, and servicing activity (Worthington, 1982).

As a movement evolves, leaders in the field often attempt to redefine its course. Consequently, a new name with a new definition emerges to describe the movement better. The transition of industrial arts to technology education encourages many to define technology education. On the basis of the existing literature, Wright (1981) defined technology education as "the study of technology, its history, growth, and future development in terms of industrial organizations as it relates to materials, tools, processes, occupations, products, and problems." As part of general education, it includes multi- and interdisciplinary academic and laboratory endeavors for the purpose of helping students explore their technological world, realize their responsibilities therein, and cope better with cultural change caused by technological advance.

More recently, Starkweather (1986) defined technology education as the comprehensive curriculum area which has an action-based instructional program concerned with technology, its evolution, utilization, and significance;

with industry, its organization, personnel, systems, techniques, resources, and products; and their combined social and cultural impacts (Starkweather, 1986). Advocates of technology education believe that there is a difference between industrial arts and technology education. To this point, Bender (1982) described the key differences between the traditional industrial arts program and a technology education program as the nature of the content as well as the process. Where a traditional program concentrates on clearly defined content structured around courses such as woodworking, metalworking, drawing, etc., with emphasis on skill and technical literacy, technology education focuses on the technical adaptive systems to promote technological literacy. A further distinction can be made in that the traditional programs focus on skills and objects where technology education focuses on human processes related to technical endeavors.

Objectives of IA/TE

Throughout its history, the purpose of industrial arts in education has been widely argued. Many have held, and some still do, that its primary purpose was related to providing vocational guidance, provocational training, or even job training (Lux, 1981). Woodward (1887), founding father of manual training, clearly stated that "the object of the introduction of manual training is not to make mechanics. We teach banking, not because we expect our pupils to become bankers; and we teach drawing, not because we expect to train architects or artists or engineers; and we teach the use of tools, the properties of materials, and the methods of the arts, not because we expect our boys to become artisans. But we do expect that our boys will at least have something to do with bankers, and architects, and artists, and engineers, and artisans; and we expect all to become good citizens. Our great object is educational: other objects are secondary." Woodward's statement obviously indicated that manual training should be organized consciously and purposively for the cultural or developmental ends of general education.

In 1949, Bess Goodykoontz, Assistant Commissioner of Education, defined the nature and purpose of industrial arts as the general education of every public school pupil. His cultural development is incomplete without concepts, understandings, and appreciations regarding manufacturing and its hosts of workers. Industrial arts as an educational field makes this desired contribution to the pupil's development. It concerns itself with the aesthetic and economic values of materials, with basic processes of manufacture, and with many problems of the workers. She continued that the public schools, through the grades, should be rich in provisions for pupil experiences which (1) teach the necessity and dignity of work; (2) illustrate the diversification of industry; (3) provide for testing personal interests and aptitudes in representative crafts; (4) serve avocational interests in construction; (5) develop consumer knowledge and appreciation; and (6) provide occupational training for those who plan to enter employment as industrial workers and for those now in manufacturing trades who desire to improve their proficiency. The first five of these points are served by industrial arts as a phase of general education desirable for all; the sixth point is the function of industrial or trade education for those who need it as specific training (United States Department of the Interior, 1949).

American Vocational Association (1953) suggested nine objectives for industrial arts which have been used extensively by many in the field. They include (1) interest in industry, (2) appreciation and use, (3) self-realization and initiative, (4) cooperative attitudes, (5) health and safety, (6) interest in achievement, (7) orderly performance, (8) drawing and design, and (9) shop skills and knowledge.

American Vocational Association (1968) addresses what it called "goals for contemporary industrial arts." They are to:

1. develop an insight and understanding of industry and its place in our culture;
2. discover and develop talents, aptitudes, interests, and potentialities of individuals for the technical pursuits and applied sciences;
3. develop an understanding of industrial processes and the practical application of scientific principles;
4. develop basic skills in the proper use of common industrial tools, machines, and processes; and
5. develop problem-solving and creative abilities involving the materials, processes, and products of industry.

More recently, Thomas Ryerson (1978) presented a report on present-day industrial arts purposes in the 65th Mississippi Valley Industrial Teacher Education Conference (MVITEC). Ryerson polled several groups to determine their rank-ordering of ten statements of purpose. Among those groups polled, the following ordered list (Table 1) reflects his data as generated by the then-membership of the MVITEC.

Through a thorough review of literature, Dyrenfurth (1981) presented a comparative listing of industrial arts objectives from previous studies by Ryerson (1978), Schmidt and Pelley (1966), Polk (1978), Froelich (1978), Wilbur and

Table 1. Ryerson's Rank Ordering of Industrial Arts Purposes

Rank	Purpose
1	Problem solving related to materials & Processes
2	Develop technical talents
3	Understand our technical culture
4	Explore occupations
5	Learn use of tools and machines
6	Technical knowledge and skill
7	Consumer knowledge
8	Pre-vocational experience
9	Develop hobby and leisure time interests
10	Vocational training for those desiring

Pendered (1967), and American Industrial Arts Association (1976). Fourteen objectives of industrial arts were identified from Dyrenfurth's compilation. They are to:

1. develop consumer knowledge, appreciation, and use of of industrial products;
2. develop basic skills in the use of common tools and machines;
3. develop safe working practices;
4. develop recreational and avocational activities of a constructional nature;
5. discover and develop creative technical talents in students;
6. provide pre-vocational experiences of an intensified nature for those students interested in technical work;
7. provide general all-around technical knowledge

(literacy) and skills;

8. provide vocational training for students who would not otherwise have this opportunity;
9. provide opportunities to identify aptitudes, abilities, and interest meaningful to career selection;
10. explore industry and American industrial and technological civilization in terms of its evolution, organization, raw materials, processes and operations, products, and occupations;
11. develop problem-solving skills related to materials, tools, and processes of industry;
12. develop desirable social relationships and personal growth;
13. provide opportunities for reinforcement of learning in other subject areas; and
14. increase an appreciation for good craftmanship and design.

Another attempt to investigate the emphasis of the industrial arts program was made by Dugger and his associates at the Virginia Polytechnic Institute and State University (Bame & Miller, 1980). They surveyed twelve possible purposes for IA education among principals, IA chairpersons, and guidance coordinators of the public schools. The survey subjects were asked to indicate their perceptions of the current degree of emphasis placed on each of the 12 purposes and their opinions on the ideal amount of emphasis for each purpose. The ranks associated with perceptions of ideal degrees of emphasis for the IA are given in Table 2.

Table 2. Rank Associated with Perceptions of IA Emphasis

Current degree of emphasis (Rank order)	Ideal degree of emphasis (Rank order)	Purpose of IA
1	1	skills in tools and machines
6	2	make informed educational and occupational choices
3	3	discover and develop creative talent
5	4	develop problem-solving skills
2	5	provide technical knowledge & skills
7	6	provide pre-vocational experiences
8	7	understand technical culture
10	8	develop consumer knowledge and appreciation
4	9	develop worthy leisure time interests
9	10	provide vocational training
12	11	understand the application of science & mathematics
11	12	develop an understanding of the nature and characteristics of technology

The survey also indicated that there is a complete congruence between current and ideal emphasis only in the top-rated purpose "skills in tools and machines." The purpose that ranked second as a current emphasis, "providing technical knowledge and skills," was rated considerably lower as an ideal than as a current emphasis. Developing "worthy leisure time interests" was also rated lower as an ideal purpose than as a current purpose. The purposes of "developing problem-solving skills relating to materials and processes" and "helping students make informed educational and occupational choices" were rated higher as ideal emphases than as current ones.

The transition of industrial arts to technology education provides a new direction in the profession. The primary object of a technology education program is to promote technological literacy. Wright (1981) points out that there are two levels of literacy in technology: technical and technological. Technical literacy includes terms that deal with the technical hardware, processes, and practical experience. Technological literacy includes terms that deal with relationships between humans and their technology, including social, cultural, and personal experiences. Technology education deals with the technological literacy which is the highest form of literacy and is essential to intelligent functioning within a society. Bender (1982) suggested the following four specific objectives for technology education:

1. to provide the learner with basic competencies for intelligent functioning within an ever-changing

technological society;

2. to develop the learner's ability for technology assessment;
3. to develop the learner's problem-solving skills with respect to complex life problems in communication, production, and transportation through the use of information resources, materials, and tools; and
4. to develop the learner's ability to discern what information and knowledge are relevant for dealing critically with any particular problem in sociotechnological systems.

The mission for technology education indicated by the American Industrial Arts Association (1983) is that technology education may be viewed as a national concern, as a mission for education, and as a stimulus for a new curriculum with new goals directed toward technological literacy. To achieve this mission, technology education will provide a comprehensive, contemporary technology education for all. This program, by its very nature, will provide insight for learners into the evolution, appropriate use, and significance of technology, the organization, systems, personnel, techniques, resources, and products of industry, and the social and cultural impacts of both industry and technology. The specific goals of technology education are to:

1. interpret the evolution and relationships of society, industry, and technical means;
2. establish beliefs and values based upon the impact of technology and how it alters environments;
3. develop attitudes and abilities in the proper use of tools, techniques, and resources of technical and industrial systems;
4. develop creative solution to present and future societal problems, using technical means; and
5. explore and develop human potentials rated to responsible work, leisure, and citizenship roles in a technological society.

In short, the goal of technology education is to provide individuals with the means to find order in a complex global society and to attain the knowledge, skills, tools, attitudes, and values required to participate effectively in the management and control aspects of a technological society (Bender, 1982).

Teaching Content and Strategies

For over sixty years, academic leaders in industrial arts education have attempted to identify the subject matter of the field in order to better "interpret" industry. Debates have raged over defining industry, identifying its organizers, and selecting contents so that the subject matter base can be systematically taught to students. Recently, many academic leaders are advocating that the central purpose of the field should shift from "interpreting industry" to "interpreting the technology." The problem of content identification continues to occupy their full attention. The current debate focuses on the following questions: How should technology be defined? What should be its content organizers? What specific content should be included in the curriculum so technology can be systematically communicated to students (Moss, 1987)? In this section, an attempt is made to provide a brief overview of the major movements or influences for industrial arts/technology education which contributed to the development of teaching contents and strategies.

Manual training

The manual training movement in the United States was influenced greatly by the Russian system and Sloyd system which were initiated in Europe. The Russian system of tool instruction and instructional shops provided the foundation for the manual training movement. Many of the elements found in the manual training movement are still visible in contemporary industrial arts/technology education programs, and some include the technical subject matter offerings (wood, drawing, metals, etc.) and instructional techniques (group instruction and instructor-dictated exercises).

The Sloyd system was another influence in modifying the educational concepts of manual training. The outstanding characteristics of the Sloyd system were individual methods of instruction, a useful project, and the encouragement of pupil initiative and self-direction (Stombaugh, 1936). Smith (1981) indicated that Larsson made a comparison between the Russian system and the Sloyd system. He pointed out that the Russian system was based on teaching the use of specific tools by completing exercises or making incomplete articles without attention being given to the individual needs and capacities of the child. Sloyd, on the other hand, used the Froebelian idea of harmonious development in children. The Sloyd system was very rigid in the use of teacher designed models for mental and moral development secured by exercise of the creative faculties.

Manual arts

Another force contributing to the development of contemporary industrial arts/technology education was the arts and craft movement. The arts and crafts movement was an attempt to restore the spirit of craftmanship and art to the production of useful articles. The emphasis on "design or art in construction, and construction in art" led many associations of art and manual training teachers to organize or combine into common groups. This combining of shop work and art instruction was a major emphasis of the arts and crafts movement and influenced manual training teachers to be conscious of design and proper construction-- an awareness that marked the beginning of the movement later known as manual arts (Martin & Luetkemeyer, 1979).

Bennett (1908) outlined a classification system for elementary school manual arts which included five major areas: (1) graphic arts, (2) mechanic arts, (3) plastic arts, (4) textile arts, and (5) book-making arts. Graphic arts included all forms of drawing, both mechanical and freehand. Mechanic arts were limited to wood and metal, while plastic arts included brick and tile making, concrete, pottery, terra cotta, and modeling. Textile arts encompassed spinning, weaving, braiding, dying, basketry, knitting, sewing, embroidery, and garment making. Bennett included printing, engraving, lettering, leather tooling, book-binding, and other artwork with paper under book-making arts. During the manual arts movement, the idea of integrating drawing and design with construction activities made a great impact on the profession (Smith, 1981).

Industrial arts movement

Influenced by John Dewey's work on the social meaning of education in an industrial society, Charles R. Richards was the first individual who recommended that the industrial education profession use the term industrial arts in place of manual training. The industrial arts movement was furthered through the work of James E. Russell, Frederick G. Bonser, Gordon O. Wilbur, and others. Their works redirected the industrial arts movement and provided new approaches to the curriculum development. Dewey's concept of education placed the study of the industrial occupations as the focal point of the elementary school curriculum. The occupations provided both the content and the method of instruction (Martin & Luetkemeyer, 1979). Richards specially defined the content for the field being drawn from industry (Smith, 1981).

Russell and Boner took a new approach in the field. They argued that a study of manufacturing industries was a base and that the goal was to develop an understanding on the part of all children about the functioning of our industrial society (Smith, 1981). Bennett developed a more flexible plan of instruction that took into account the individual differences of students (Smith, 1981). Wilbur (1948) suggested an industrial arts curriculum development approach based on behavioral changes in preference to the trade or occupational analysis approach in his earlier publications. As outlined by Wilbur, the process of curriculum development was based on statements of objectives, changes in behavior on the part of the students in relation to the objectives, and the activities, lessons, demonstrations, and projects related to bringing about behavior changes.

Another individual who had significant influence on what should be taught in industrial arts was Delmar Olson. Influenced by the work of William Warner, Olson recommended that the subject matter for industrial arts be derived from a study of technology as represented in industry. He listed eight major categories of technology: manufacturing, construction, power, transportation, electronics, research, services, and management (Miller & Smalley, 1963). Olson's work provided a basic curriculum development foundation for the contemporary industrial arts/technology education movement. Other significant events and movements which are worthy of mention during the period of industrial arts movement are listed below:

1. placed more emphasis on consumer knowledge as industrial arts' primary objective;

2. emphasized both an exploratory objective and the concept of the general shop;

3. emphasized that industrial arts education be considered a curriculum area rather than a specific subject and that it have general values to apply to all levels of education;

4. included aviation industry as a source of content during the World War II;

5. placed emphasis on mass production as a method of teaching or as a unit of study;

6. placed emphasis on research and experimentation as a method of teaching in industrial arts; and

7. emphasized problem-solving or "discovery" as the method of teaching, rather than drill. Problem-solving as a method of instruction became an important part of industrial arts curriculum development (Martin & Luetkemeyer, 1979; Smith, 1981).

Curriculum reform in the 1960s

With an initial impetus coming from the launching of Sputnik, the late 1950s and 1960s began a period of intense curriculum reform throughout the United States. Immense funding through the National Defense Education Act, the National Science Foundation, the Ford Foundation, and other private sources led to substantial changes in many phases of curriculum development (Martin & Luetkemeyer, 1979). A fundamental re-examination of the functions, purposes, and content of industrial arts education took place during the 1960s. In a publication, "Improving Industrial Arts", Ivan Hostetler identified four objectives that should be emphasized in industrial arts education:

1. to develop in each student an insight and understanding of industry and its place in our culture;

2. to discover and develop talents of students in the technical fields and applied sciences;

3. to develop technical problem-solving skills related to materials and processes; and

4. to develop in each student a measure of skill in the use of the common tools and machines (USOE, 1962).

These four objectives provided the framework for many of the curriculum innovations of the 1960s (Martin & Luetkemeyer, 1979).

The United States Office of Education (USOE) conducted two industrial arts education surveys between 1961 and 1963. The results of the surveys indicated a gap between theorists at the professional level and actual programs at the secondary school level. Most of the industrial arts programs listed in the state guides were technically oriented and the trade and job analysis philosophy continuously dominated the industrial arts curriculum development (USOE, 1961). Instructional programs concentrated on drafting, woods, and metals. The report also indicated that the current industrial arts curriculum does not even measure up to the program recommended by the profession 10 to 20 years ago (USOE, 1966). The need for reorganizing the industrial arts curriculum along with the curriculm reform movement stimulated several massive efforts to redirect drastically the industrial arts.

Householder (1979) classified the industrial arts curriculum innovation efforts that characterized the decade into four types:

1. Industry-centered curriculum development efforts. This approach, including Industrial Arts Curriculum Project and American Industry Project, focused upon the goods-producing industries, sought to minimize the involvement with individualized crafts-oriented project production, and most of them sought substantial broadening of the coverage of content from industry.

2. Study of technology. The influence of technology upon people was used as the central theme in industrial arts curriculum development in this approach. Concentration upon instruction in technology, science, and the humanities was recommended. DeVore and his colleagues had made significant efforts toward the development of an organized structure from which technologically-based courses could be developed.

Their work provided a foundation for the current technology education movement.

3. Individual development as a central theme. The Maryland plan was a typical example of this approach. The educator is concerned that the overall unit coverage is organized to offer all individuals an opportunity for exploration and learning within the framework of the unit. Active student involvement is a central theme. Individuals work separately and collectively on group projects, research and experimentation, line production, and various technical development projects. Emphasis upon problem-solving, interaction with the industrial world outside the school, reporting to the entire group upon the results of one's investigation, and reliance upon the learner as a productive person are unique features of the Maryland Plan.

4. The evolutionary approach to curriculum development. This approach to curriculum improvement was built directly upon the existing program. The curriculum developer seeks to improve the existing program by modifying it, updating it, deleting out-dated material, introducing new concepts, and providing for newly-introduced technologies.

The decade of the 1960s witnessed the first concerted efforts at the development of curriculum innovation in industrial arts education. The ten-year period was not long enough for the diverse curriculum development activities to attain a cohesive position. As the profession moved into the 1970s, however, it did so with the confidence that it could work effectively at self-improvement, that it was possible to accomplish considerable modification within the roles traditionally available to industrial arts, and with a new enthusiasm for the search for better ways (Householder, 1979).

Jackson's Mill Curriculum Theory

The Jackson's Mill Industrial Arts curriculum document was an endeavor of 21 industrial arts educators who attempted to translate the debate about the direction and future of industrial arts into action during 1979-81. This curriculum document serves as a foundation for much of the thought that has evolved in the technology education movement (Starkweather, 1986). Several important accomplishments can be identified from this document:

- Provided a foundation for reconciliation of the divergence that exists within industrial arts--industry and technology.

- Stated clearly that the main objective of industrial arts education is to contribute to technological literacy and to enhance human potential.

- Identified that the content for industrial arts is drawn from the knowledge of the three systems of human adaptive behavior and human technical endeavors that exist to extend human potential.

- Specified the subsystems of the human technical endeavor to be communication, construction, manufacturing, and transportation from which the teaching content of industrial arts can be derived. Each of these subsystems represents a discrete human endeavor that can be studied in isolation (Hales & Snyder, 1982).

<u>Technology education movement</u>

The major goal of technology education is to achieve technological literacy. This raises the issues of what schools can do to develop in the citizenry a reasonable degree of technological literacy. This is a pressing problem that will require our best thinking and perhaps a movement into new and different forms of content involvement. The content of technology education has been put forth by numerous authors in and out of the profession. The challenge to the profession is to establish some form of direction and focus for the program as it will be conducted in the total school spectrum (Maley, 1987b). Martin (1985) indicated that the content for general instruction in technology must be broadly conceived. He further pointed out several directions for developing proper content for technology education instruction. It must be flexible and have the ability to change as society changes. The content must be current; it must represent the present. It must be generalizable and future-oriented, as well as reflective of the major social, economic, and political factors that influence the world habitat. The content also must have a sound and well-developed technical knowledge base that is used to guide critical thinking and problem-solving activities.

Maley (1987b) suggested that serious consideration should be given to the following list of items contributing to technological literacy as proposed by the National Science Foundation. These understandings can help facilitate literacy of technology in today's society:

1. the historical role of technology in human development,
2. the relationship between technological decisions and human values,
3. the benefits and risks of choosing technologies,
4. the changes occurring in current technology, and
5. the understanding of technology assessment as a method for influencing the choice of future technology.

Maley regarded that these five areas of contribution to technological literacy provide a comprehensive prescription of understanding to be achieved in technology education programs. He further suggested some potential contents and projects for technology education in the implementation of these areas of technological literacy. Technology education implementation activities should include the following developments: tools and machines, power and energy, communications and transportation, and the contriubution of these developments to the growth of civilization.

The relationship between technological decisions and human values could be taught by using a contemporary community planning or city reconstruction activity such as local community redesign and transportation system design. The understanding for the benefits and risks of choosing technologies could involve a contemporary and futuristic series designed to explore the alternatives to various technological systems such as energy development, housing development, and pollution control. The contemporary and futuristic approach to the changes occurring in current technology would take a series of current technological developments and examine what is happening in each. This could be accomplished through units of study dealing in such topical areas as modern manufacturing processes, modern transportation systems, modern and futuristic construction processes, communication processes, energy development processes, and shopping and merchandising processes.

The dimensions of technology assessment in the technology education program can assume numerous directions as well as levels of inquiry. Some of these could be related to the following topics or categories: environmental impact, health and hazard efforts, ethical implications, social issues, use of finite resources, impact on the common good, resultant waste and disruption, impact on living standards, whose interests are being served, proven worth of a technology, technological alternatives, etc.

DeVore (1987) suggested that the essential elements of technology education programs should consist of, but not be limited to the following categories of knowing and doing:

1. knowledge and understanding of the history, evolution, nature and development of technical means including people, places and cultures where the means were invented and developed;

2. knowledge and understanding of the processes of invention and innovation including experience in the process;

3. knowledge and understanding of the behavior of adaptive systems and subsystems such as communication,

production, and transportation, including the tools, machines, materials, techniques, and technical means used in these systems; and

4. knowledge and understanding of the behavior of various technical elements and adaptive systems, and the assessment of the impact of these elements and systems in relation to human beings, society, and the environment.

Lauda (1983) argued that curriculum should be built around great ideas, issues, concepts, and values that a society wants continued for its members. He emphasized the fundamental concepts that the student can transfer to new situations. Those important concepts that the student must revisit in the K-12 curriculum are curriculum development constants including technology, communications interdependence, environment, multi-national corporations, social change, computers, robotics, energy, finite resources, systems, values, post-industrial society, technology assessment, geo-politics, heritage, change, problem-solving, decision-making, population, rich-poor gap, and affluence. Some of these constants may seem to be oriented towards the social studies. However, Lauda argued that technology education discipline can assist in the conceptual understanding of these.

A review of the literature reveals that the four industrial/technological systems (communication, construction, manufacturing, and transportation) at least for now, are widely accepted to be the instructional content of technology education programs (Lauda & McCrory, 1986; Lauda, 1983; Sterry, 1987; Herschback, 1984; Sullivan, 1987; Starkweather, 1986).

Problems

As the profession shifts its new emphasis on technology education, concern and speculation over the problems and possible directions that the technology education movement is facing have become the theme of a great number of journal articles, editorials, speeches, and forums. The literature revealed that the contemporary industrial arts/technology education programs are plagued with several rather serious problems, including the debate over the philosophical base of technology education, teacher shortage, enrollment decline in secondary schools, closing of teacher preparation programs, lack of a well-defined content base, and inadequate facilities.

Herschback (1984) indicated that the debate over the issue of instructional content for industrial arts is important and complex. It is important because the continued existence of industrial arts depends mainly on its acknowledged educational value as a school subject, and complex because industrial arts is not a formal discipline, lacks a recognized body of knowledge, and has no well-defined content base. He also questioned the rationale for selecting specific technical categories in the Industrial Arts Curriculum Project, the American Industrial Project, and the Jackson's Mill Curriculum document.

Herschback argued that approaches that attempt to define categories representative of technology must resolve three major curriculum problems. First, there must be an established "rational basis" for selecting specific categories. Why, for example, include construction but not power or agriculture? The second problem to be dealt with is the scope of content represented. It is obvious that all teachable content "can not be included in a given curriculum. Selection is essential." Just what, in a given category, should be studied? The third problem to be considered is the gigantic conceptual leap that is often made from general categories, such as transportation or energy, to actual classroom instruction. In other words, often there is a marked difference between the implied scope of knowledge and study, and the actual activity and results.

The shortage of industrial arts/technology education teachers is well-documented. Edmunds (1980) observed that the field of industrial arts education has experienced an acute shortage of teachers since early in the 1960s. Much has been written, many conferences held, and considerable committee work done in an attempt to solve this problem. The literature suggested that the causes of the teacher shortage may include the closing of industrial arts teacher training programs in colleges and universities (Savage, 1985; Feirer, 1984), low percentage of graduates from the industrial arts teacher training institutions are entering education (Worthington, 1982), a high percentage of industrial arts teachers leave teaching for industry positions (Feirer, 1984), and teacher preparation programs continue to lack effective recruitment strategies (Edmunds, 1980; Worthington, 1982; Edmunds, 1982; Sharpe & Householder, 1984).

Savage (1985) identified five factors (student, faculty, curriculum, facility/equipment, and product), which may have contributed to the closing of the IT/TE teacher preparation programs. He further pointed out that student factors that have contributed to program shut down are low enrollment, insufficient student recruitment, and the growth of industrial technology programs which vie for the same type of students. A study by Roiter and his associates (1983) noted that, in the institutions studied, industrial teacher education programs were understaffed. As a consequence, faculty were required to have many different preparations per semester or quarter to cover courses that had to be taught. The Savage study (1985) also indicated that laboratory courses that are costly to operate and do not have a sound philosophical base and rationale may be in constant jeopardy. Many industrial education programs have a low production of certified industrial arts graduates. Further, many programs have a lower number of graduates who actually go into teaching. They accept positions in business and industry, even though there is a demand for them as teachers in most states.

Feirer (1984) indicated that only 66% of industrial arts teacher education program graduates are still teaching at the end of the first year, only 50% at the end of the second year, and only 40% at the end of the third year. The reasons given by most of these new teachers for leaving the profession are (a) low salaries, (b) personal dissatisfaction with the job, and (c) impatience with the students. Those who do stay indicated that they get a great deal of self-satisfaction from their jobs, are looking forward to advancement, and are interested in working with students in the areas of science and technology.

Edmunds' study (1982) reported that considerations strongly impacting the decision to leave industrial arts teaching career are (a) salaries and other forms of compensation, (b) lack of administrative support for industrial education, (c) availability of resources and facilities, and (d) influence of drugs and alcohol upon safety factors. His results also indicated that a majority of those individuals that leave teaching would return if compensation and administrative support were improved.

Another serious problem facing industrial arts/technology education programs is the decreased enrollment in the junior and senior high school programs (Feirer, 1984; Maley, 1987a; Schoonmaker, 1984; Dugger et al., 1987). The main reasons for decreased enrollment are (1) increased college entrance requirements, (2) increased graduation requirements on mathematics, science, foreign languages, and arts, and (3) no industrial arts/technology education requirement in the high school curriculum.

Schoonmaker (1984) observed that there is a movement toward expanding college entrance requirements in mathematics, science, and language courses. As a result, there may be less time available for elective courses in students' schedules. Industrial arts could well be one of the elective subject areas affected by these developments.

Maley (1987b) expressed similar concern. He argued that part of the reason technology courses are not required is the tendency in many curriculum restructuring efforts to increase the requirements for mathematics, science, art, and foreign languages in general education, leaving little room for industrial arts or technology education. A survey conducted by Dugger and his colleagues (1987) indicated that only about one-fourth of the states reported that fields like technology education/industrial arts and trade and industrial education were included in increased graduation requirements for students. Nearly 90% of the respondents indicated that increased graduation requirements in academic subjects were limiting the time students had available to take courses in technology education, and trade and industrial education.

Two other problems faced by industrial arts/technology education are the problem of inadequate financial resources (Worthington, 1982) and competition for student source with industrial technology programs (Conley, 1978). Conley's report indicated that much of the decline in teacher education enrollments seemed to be a shifting of enrollments from teacher education programs to non-teaching technical programs.

Summary

This chapter presents a review of literature concerning industrial arts/technology education in view of historical perspective, philosophical views, teaching contents and strategies, and problems and directions.

The roots of industrial education reach deep into the history of civilization. However, it was not until 1883 that manual training, the precursor of technology education, began in the public schools of the United States. Throughout the history of what is currently called the technology education movement, there has been a continuing change in the nature of its content and an appropriately descriptive name for this field. The early leaders advocated such titles as manual training, Sloyd, manual arts, industrial arts, and presently technology education. Each name was based on a different interpretation of the content base. Manual training established the manipulative skill development as the key element in the early programs. Manual arts introduced project-making with increased emphasis on creativity and improved design to previous manual training, and industrial arts added elements and organization of industry. The current technology education movement focuses its instruction on providing technological literacy for all citizens.

The philosophical views of IA/TE have been a subject of debate within the profession since its inception. The most recent definition of technology education given by Starkweather (1986) states that technology education as the comprehensive curriculum area has an action-based instructional program concerned with technology, its evolution, utilization, and significance; with industry, its organization, personnel, systems, techniques, resources, and products; and with their combined social and cultural impacts.

It appears from the literature reviewed that the purpose of traditional industrial arts programs was placed on developing basic skill in the use of common tools and machines, consumer knowledge, recreational and avocational activities, and pre-vocational experiences. The primary object of a current technology education program is to promote technological literacy which provides individuals with a means to find order in a complex global society, and to attain the knowledge, skills, tools, attitudes, and values required to participate effectively in the management and control aspects of a technological society.

The issue of what should be taught in IA/TE has been debated for years because it lacks a recognized body of knowledge and has no well-defined content base. For over sixty years, leaders in IA education have attempted to identify the subject matter of the field in order to interpret industry better. Consequently, the industry has become the source from which instructional content of IA is derived.

Another focal point of IA curriculum development is the study of technology. The technology becomes the source of teaching content from which the goal of technological literacy can be achieved. The instructional content based on the four "industrial/technological systems" (communication, construction, manufacturing, and transportation, as proposed by the Jackson's Mill group) has been widely accepted by the profession.

The literature reveals that the contemporary IA/TE programs are confronting several serious problems. These problems include the debate over the philosophical base of technology education, teacher shortage, enrollment decline of IA/TE programs in the secondary schools, closing of teacher preparation programs, lack of a well-defined content base, and inadequate facilities.

The feasible strategies and directions for solving the problems which are currently plaguing the technology education movement have been eagerly pursued by many who are in and out of the profession. Their viewpoints and suggestions are presented in Chapter IV.

CHAPTER III. METHODOLOGY

This chapter describes the research procedures, methodologies, and analyses used in this study. The following sections included are (1) definition of the population and identification of the samples, (2) data collection instrument, (3) variables of the study, (4) research hypotheses, and (5) methods of statistical analysis of data.

Definition of the Population and Identification of Sample

This study was designed to investigate the developing trends, the issues, and the prospects of industrial arts/technology education programs at the college level. The chairpersons of these programs were selected as the subjects of the study. Two hundred and twelve subjects were identified from the 1987-88 edition of the Industrial Teacher Education Directory (Dennis, 1987).

Data Collection Instrument

An industrial arts/technology education programs survey form was employed to collect data for this study. This survey form consisted of three parts. The first part of the questionnaire contained items designed to gather information about program type, highest degree offered, enrollment trends, employment trends, graduates' salary, faculty specialty area, curriculum emphasis, perception of technology impact, and adaptation of technology. The second part of the questionnaire listed possible philosophical objectives, problems, and directions of current technology education programs which were gathered from a review of the literature. The respondents were requested to answer items on a five-point scale of agreement. A choice of "5" indicates strongly agree, "4" agree, "3" neutral, "2" disagree, and "1" strongly disagree that the item represents their best answer. The third part of the questionnaire consisted of thirteen questions concerning the prospects of technology education.

The initial draft of the questionnaire was reviewed for content validity, plausibility of items, and appropriateness. The questionnaire was revised, based on the recommendations of the review, and sent to the research subjects.

Variables of the Study

The following independent and dependent variables were included in this study:

Independent variables:

1. subject group
2. highest degree offered

3. enrollment trends of IA/TE program
4. enrollment trends of IT program
5. employment trends
6. graduates' starting salary in teaching
7. graduates' starting salary in industry
8. faculty specialty area
9. curriculum emphasis in 1981-82 (7 possible)
10. curriculum emphasis in 1986-87 (7 possible)
11. perception of technological impact (8 possible)
12. adaptation of new technologies (8 possible)
10. philosophical objectives

Dependent variable:

1. philosophical objectives (17 possible)
2. problems: teacher factor (8 possible)
3. problems: enrollment factor (7 possible)
4. problems: teaching content factor (4 possible)
5. problems: facility factor (2 possible)
6. directions: teacher factor (8 possible)
7. directions: enrollment factor (9 possible)
8. directions: teaching content factor (5 possible)
9. directions: facility factor (6 possible)
10. prospects of technology education (13 possible)

Research Hypotheses

There were eight research hypotheses to be tested in this study.

Research hypothesis 1

It was hypothesized that the means for philosophical objectives of technology education are equal among three survey groups (TE, TE/IT, and TE/IT/VT).

Ho: $U1i = U2i = U3i$

Ha: $U1i \neq U2i \neq U3i$

where $i = 1$ to 4 (number of objective factors)

Research hypothesis 2

It was hypothesized that the means for problems confronting technology education programs are equal among three survey groups.

Ho: $U1i = U2i = U3i$

Ha: $U1i \neq U2i \neq U3i$

where $i = 1$ to 6 (number of problem factors)

Research hypothesis 3

It was hypothesized that the means for possible solutions to problems confronting technology education programs are equal among three survey groups.

Ho: $U1i = U2i = U3i$

Ha: $U1i \neq U2i \neq U3i$

where $i = 1$ to 6 (number of solution factors)

Research hypothesis 4

It was hypothesized that the means for prospects of technology education are equal among three survey groups.

Ho: $U1i = U2i = U3i$

Ha: $U1i \neq U2i \neq U3i$

where $i = 1$ to 3 (number of prospect factors)

Research hypothesis 5

It was hypothesized that the selected independent variables (enrollment trends of TE program, enrollment trends of IT program, percentage of TE graduates' employment in teaching in 1981-82 and in 1986-87, graduates' starting salary for teaching, graduates' starting salary for working in industry, percentage of faculty specialty in TE, curriculum emphasis in 1986-87, perception of technological impact, and technology adaptation) do not contribute to the prediction of subjects' perception of the four philosophical objective factors of technology education.

Ho: $(Beta)ij = 0$

Ha: $(Beta)ij \neq 0$

where $i = 1$ to 4 (number of objective factors)

$j = 1$ to 10 (number of independent variables)

<u>Research hypothesis 6</u>

It was hypothesized that the selected independent variables do not contribute to the prediction of the subjects' perception of the six problem factors of technology education.

Ho: (Beta)ij = 0

Ha: (Beta)ij $\neq$ 0

where i = 1 to 6 (number of problem factors)

j = 1 to 10 (number of independent variables)

<u>Research hypothesis 7</u>

It was hypothesized that the selected independent variables do not contribute to the prediction of the subjects' perception of the six solution factors of technology education.

Ho: (Beta)ij = 0

Ha: (Beta)ij $\neq$ 0

where i = 1 to 6 (number of solution factors)

j = 1 to 10 (number of independent variables)

<u>Research hypothesis 8</u>

It was hypothesized that the selected independent variables do not contribute to the prediction of the subjects' perception of the three prospect factors of technology education.

Ho: (Beta)ij = 0

Ha: (Beta)ij $\neq$ 0

where i = 1 to 3 (number of prospect factors)

j =1 to 10 (number of independent variables)

Methods of Statistical Analysis of Data

This section summarizes the statistical techniques which were used to test the research hypotheses of the study.

The mean, standard deviation, and frequency distribution were employed to describe the general characteristics of industrial arts/technology education programs as well as subjects' responses to the questionnaire items pertaining to philosophical objectives, teaching contents, problems, directions, and prospects of technology education.

The chi-square and one-way analysis of variance were used to test significant differences among the three subject groups for discrete and continuous variables, respectively.

The items of the instruments used to investigate the perception of objective, problem, solution, and prospect of technology education, respectively, were intercorrelated. The factor analysis technique was used to derive appropriate factors which were used for further analysis. Factor scores were defined as the mean of the item scores constituting the factor.

In order to test hypotheses 1 through 4, the one-way analysis of variance was used to examine the differences in the means of the variable factors for objective, problem, direction, and prospect of technology education among the three survey groups.

For hypotheses 5 through 8, stepwise multiple regression analysis was used to examine the unique contributions of selected independent variables to the variance of variable factors for objective, problem, solution, and prospect of technology education.

CHAPTER IV. RESULTS AND FINDINGS

In this chapter, the results and findings of the study are presented. There are five sections in this chapter: (1) results of survey responses, (2) program characteristics, (3) item analysis, (4) factor analysis, and (5) hypothesis testing.

Results of Survey Response

The survey instrument was administered to 212 department chairpersons of the IA/TE teacher education programs identified from the 1987-88 Edition of the Industrial Teacher Education Directory (Dennis, 1987). One hundred and forty-one questionnaires (67%) were returned. Twenty questionnaires were not usable because they were partially completed. Thus, there were one hundred and twenty-one (57.1%) returned questionnaires containing information that was coded and used in the data analysis process.

The subjects were categorized into three department groups (departments which offer IA/TE program only, departments which offer both IA/TE and IT programs, and departments which offer vocational/technical programs in addition to the IA/TE and/or the IT program). The group distribution is summarized in Table 3.

Table 3. The number and percentage of respondents in sample

Group	Number	Percent
TE	19	15.7
TE/IT	53	43.8
TE/IT/VT	49	40.5
Total	121	100.0

TE: IA/TE program only
TE/IT: both IA/TE and IT programs
TE/IT/VT: vocational/technical programs and IA/TE and/or IT programs

Program Characteristics

The first part of the survey form contained items concerning characteristics of IA/TE teacher education programs. The data in this part included the highest degree offered, enrollment trends of the IA/TE program, enrollment trends of the IT program, IA/TE graduates' employment by category, IA/TE graduates' starting salary for teaching, IA/TE graduates' starting salary for working in industry, faculty specialty area, curriculum emphasis in 1981-82, curriculum emphasis in 1986-87, technological impact on the program, and adaptation of technologies into the program. For a better understanding of the variance of these program characteristic data, chi-square and one-way analysis of variance techniques were performed to test the differences within the discrete and continuous data, respectively, among the three department groups.

Table 4 reports the summary of category, percentage, value, and significance of the chi-square test for the three discrete variables.

Table 4. The summary of category, percentage, value and significance of chi-square testing for discrete variables

Variable/Category	Percent	Chi-square Value	Chi-square Significance
1. Highest degree offered			
a. bachelor	28.1	25.096	0.002*
b. master	46.3		
c. EdS	5.0		
d. PhD or EdD	19.8		
e. others	0.8		
2. TE enrollment trends			
a. increase	12.7	3.391	0.495
b. remain the same	29.1		
c. decrease	58.2		
3. IT enrollment trends			
a. increase	59.8	6.077	0.194
b. remain the same	21.8		
c. decrease	18.4		

* Significant at the $P < .05$ level.

Highest degree offered

A significant difference was found among the three subject groups concerning the highest degree offered in the departments. About 46 percent of the departments which have industrial arts/technology education teacher education programs reported that the highest degree they offer is at the master's level, while 20 percent offer a Ph.D. or an Ed.D. degree and about 28 percent offer only a bachelor's degree program. Note that the number of observation in some cells is relatively small. Thus, the significance of the test might be invalid.

Enrollment trends of the IA/TE programs

No significant difference was found among the three department groups regarding the enrollment trends of the industrial arts/technology education programs. The results of the study indicated that about 13 percent of the IA/TE programs experienced an enrollment increase in the 1986-87 school year as compared to 1981-82. However, more than one-half of the IA/TE programs suffered an enrollment decrease during the same period. Approximately 29 percent of the program's enrollment retained at the same level as 1981-82.

Enrollment trends of the IT programs

No significant difference was found among the three department groups in terms of the enrollment trends of the industrial technology programs. The results showed that about 60 percent of the IT programs had an enrollment increase in the 1986-87 school year as compared to 1981-82, while 18 percent of the programs experienced an enrollment decrease, and 22 percent had a constant enrollment over the five-year period.

Mean, standard deviation, and one-way analysis of variance of the continuous variables pertaining to information about program characteristics are summarized in Table 5. The one-way analysis of variance was used to test for significant differences of means for the continuous variables among the three department groups. The Scheffé technique is, then, used to test the difference between each pair of two groups when the variables show significant differences among three groups from the one-way analysis. In addition to the total mean, standard deviation, and value and significance of F-ratio, the individual group means, and standard deviations are also reported in the table for those variables that have significant differences among three groups. It was found that only graduate's employment by category (teaching, working in industry, and self-employment) in 1986-87, graduate's self-employment in 1981-1982, faculty specialty in IA/TE and vocational/technical education, and curriculum emphasis in manufacturing in 1981-82 revealed significant differences among the three department groups.

Table 5. The mean, standard deviation, value, and significance of one-way analysis of variance for continuous variables among the three department groups

Variable	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. IA/TE enrollment trends in percentage compared to the 1981-82 school year						
	Total	110	-21.33	34.96	.723	.488
2. IT enrollment trends in percentage compared to the 1981-82 school year						
	Total	87	44.70	197.42	.355	.702
3. TE graduate's employment in teaching in percentage for the 1981-82 school year						
	Total	104	59.61	27.00	2.046	.133
4. TE graduate's employment in industry in percentage for the 1981-82 school year						
	Total	104	35.53	26.55	2.055	.133
5. TE graduate's self-employment in percentage for the 1981-82 school year						
	1	16	6.25	5.32	3.847	.0245*
	2	45	6.89	9.73		
	3	43	2.74	4.10		
	Total	104	5.08	7.44		
6. TE graduate's employment in teaching in percentage for the 1986-87 school year						
	1	18	62.89	22.09	4.059	.020*
	2	45	42.07	31.83		
	3	42	56.14	30.48		
	Total	105	51.27	30.73		

* Significant at the P < .05 level.

Table 5. (continued)

Variable	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
7. TE graduate's employment in industry in percentage for the 1986-87 school year						
	1	18	30.00	19.48	3.933	.023*
	2	45	51.71	29.78		
	3	42	41.83	30.26		
	Total	105	44.04	29.32		
8. TE graduate's self-employment in percentage for the 1986-87 school year						
	1	18	7.11	9.92	4.146	.019*
	2	45	6.22	9.72		
	3	42	2.02	3.26		
	Total	105	4.70	8.64		
9. TE graduate's salary in thousands for teaching in the 1986-87 school year						
	Total	106	17.16	2.19	.203	.816
10. TE graduate's salary in thousands for working in industry for the 1986-87 school year						
	Total	91	21.43	3.03	0.814	.446
11. Faculty's specialty area in IA/TE in percentage						
	1	19	74.32	27.34	5.360	.006**
	2	51	56.43	33.80		
	3	47	48.30	25.67		
	Total	117	56.07	30.33		
12. Faculty's specialty area in vocational/technical education in percentage						
	1	19	20.53	28.81	3.351	.039*
	2	51	20.00	26.67		
	3	47	32.70	23.32		
	Total	117	25.19	26.25		

** Significant at the P < .01 level.

Table 5. (continued)

Variable	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
13. Faculty's specialty area in engineering in percentage						
	Total	117	7.94	14.18	1.611	.204
Curriculum emphasis for 1981-82 school year (based on the 5-point Likert scale)						
14. Curriculum emphasis in professional education						
	Total	113	3.73	.89	.238	.789
15. Curriculum emphasis in electronics/computer						
	Total	110	2.74	1.11	1.620	.203
16. Curriculum emphasis in CAD/CAM/CIM						
	Total	111	1.81	1.02	.804	.450
17. Curriculum emphasis in manufacturing						
	1	17	3.12	.99	4.500	.013*
	2	49	2.69	1.10		
	3	46	3.30	.89		
	Total	112	3.01	1.04		
18. Curriculum emphasis in power/energy						
	Total	112	2.94	0.96	.960	.385
19. Curriculum emphasis in graphic communication						
	Total	112	3.13	1.07	.080	.927
20. Curriculum emphasis in construction						
	Total	110	2.91	1.16	.843	.433

Table 5. (continued)

Variable	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
Curriculum emphasis in 1986-87 school year (based on the 5-point Likert scale)						
21. Curriculum emphasis in professional education						
	Total	111	3.78	.95	2.720	.070
22. Curriculum emphasis in electronics/computer						
	Total	110	3.61	.94	.380	.683
23. Curriculum emphasis in CAD/CAM/CIM						
	Total	109	3.63	1.06	1.530	.221
24. Curriculum emphasis in manufacturing						
	Total	111	3.69	.99	.166	.847
25. Curriculum emphasis in power/energy						
	Total	111	3.41	1.04	1.673	.193
26. Curriculum emphasis in graphic communication						
	Total	110	3.50	1.06	.953	.389
27. Curriculum emphasis in construction						
	Total	109	3.27	1.14	1.292	.279
Impact of technologies on programs (based on 5-point the Likert scale)						
28. computer						
	Total	113	4.21	.92	2.500	.087
29. Digital electronics						
	Total	112	3.32	1.16	.663	.517

Table 5. (continued)

Variable	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
30. NC/CNC						
	Total	113	3.42	1.17	.022	.979
31. Robotics						
	Total	114	3.33	1.24	.135	.874
32. CAD						
	Total	114	3.83	1.17	.655	.520
33. CAM						
	Total	114	3.41	1.15	.042	.959
34. Laser						
	Total	112	2.22	1.22	.958	.387
35. Tabletop publishing						
	Total	111	2.71	1.38	2.064	.132
Adaptation of technologies into programs (based on the 5-point Likert scale)						
36. Computer						
	Total	110	4.15	.75	.413	.663
37. Digital electronics						
	Total	109	3.35	1.13	.648	.525
38. NC/CNC						
	Total	109	3.50	1.09	.165	.848
39. Robotics						
	Total	110	3.34	1.18	.854	.428

Table 5. (continued)

Variable	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
40. CAD						
	Total	110	4.10	.88	.021	.979
41. CAM						
	Total	109	3.44	1.05	.475	.623
42. Laser						
	Total	109	2.23	1.24	1.342	.266
43. Tabletop publishing						
	Total	106	2.88	1.35	.168	.846

<u>IA/TE teacher education enrollment trends</u>

No significant difference was found concerning the enrollment trends of industrial arts/technology education programs among the three department groups. Compared to the 1981-82 school year, IA/TE programs suffered about a 21 percent enrollment drop.

<u>IT enrollment trends</u>

No significant difference was found regarding the enrollment trends of industrial technology programs among the three department groups. Compared to the 1981-82 school year, industrial technology programs experienced about a 45 percent enrollment increase.

IA/TE graduates

No significant difference existed among the three department groups concerning the percentages of IA/TE graduate's employment in teaching and working in industry in 1981-82 school year. A significant difference was found among the three groups in the self-employment category. The percentage of graduates for self-employment in the TE group was significantly higher than the TE/IT/VT group. About 60 percent of the IA/TE graduates went into teaching, while 35 percent went into industry, and about 6 percent were self-employed during 1981-82. Significant differences were also found among the three department groups regarding the percentages of IA/TE graduates' employment in all three categories: teaching, working in industry, and self-employment during the 1986-87 school year. The results of the study indicated that (1) about 51 percent of the IA/TE graduates went into teaching, which dropped by almost 9 percent as compared to the 1981-82 school year, (2) a significantly higher percentage of the graduates from the TE group went into teaching than those graduates from the TE/IT group, (3) about 44 percent of the IA/TE graduates went into industry, which increased by 9 percent from the 1981-82 school year, and (4) more IA/TE graduates (51%) from the TE/IT department group went into industry than those (30%) from the TE department group.

Salary of IA/TE graduates

No significant difference was found among the three department groups in terms of IA/TE graduate's salary in teaching or working in industry. The results indicated that the average starting salary of IA/TE graduates was $17,160 for teaching and $21,430 for working in industry during the 1986-87 school year. It should be noted that those working in industry are employed on a 12-month basis, while teachers generally work 9 or 10 months.

Specialty area of faculty

Significant differences were found among the three department groups regarding the percentage of faculty's specialty in industrial arts/technology education and in vocational/technical education, but no significant difference existed for the specialty area in engineering among these three groups. The results of the study showed that (1) about 56 percent of faculty in the departments surveyed had a specialty area in IA/TE, approximately 25 percent in vocational/technical education, and 8 percent in engineering; (2) the TE department group had a significantly higher percentage of faculty who had a specialty area in IA/TE than the other two department groups; (3) the TE/IT/VT department group had a significantly higher percentage of faculty who had a speciality area in vocational/technical education than in TE and TE/IT groups.

Curriculum emphasis

The emphasis of seven curriculum concentration areas (professional education, electronics/computer, CAD/CAM/CIM, manufacturing, power/energy, graphics communication, and construction) was rated by the chairpersons from the three department groups. Significant differences were found among the three groups only in manufacturing during the 1981-82 school year. The results of the study showed that: (1) during the 1981-82 school year, the weight of IA/TE curriculum emphasis was 3.73 (based on a 5-point Likert scale) for professional education, 3.13 for graphics communication, 3.01 for manufacturing, 2.94 for power/energy, 2.91 for construction, 2.74 for electronics/computer, and 1.81 for CAD/CAM/CIM areas; (2) during 1986-87 school year, the rank and average weight of the curriculum emphasis was 3.78 for professional education, 3.69 for manufacturing, 3.63 for CAD/CAM/CIM, 3.61 for electronics/computer, 3.50 for graphics communication, 3.41 for power/energy, and 3.27 for construction; and (3) all six technical curriculum areas received considerable attention, especially in CAD/CAM/CIM and electronics/computer as compared to the 1981-82 school year.

Impact of technologies on programs

No significant difference was found among the three department groups concerning how significantly technologies such as computers, digital electronics, NC/CNC, robotics, CAD, CAM, laser, and tabletop publishing, impacted on their programs. The results indicate that the computer had the most significant impact (4.21, based on a 5-point Likert scale) on the IA/TE programs, followed by CAD (3.83), NC/CNC (3.42), CAM (3.41), robotics (3.33), digital electronics (3.32), tabletop publishing (2.71), and laser (2.22) technologies.

Adaptation of technologies into programs

The respondents were asked to indicate how well their departments adapt these technologies into the existing programs. No significant difference was found among the three subject groups in this respect. The results of the study showed that the computer had been adapted best (4.15 on the 5-point Likert scale) into the existing programs, followed by CAD (4.10), NC/CNC (3.50), CAM (3.44), digital electronics (3.35), robotics (3.34), tabletop publishing (2.88), and laser technologies (2.23).

Item Analysis

Parts 2 and 3 of the survey questionnaire consisted of eighty items for collecting data pertaining to philosophical objectives, problems, solutions of the problems, and prospects of industrial arts/technology education. For a better understanding of the relative importance of the rating and variance of each individual item, item analysis was performed to report mean, standard deviation, and results of the one-way analysis among the three department groups.

Philosophical objectives

The department chairpersons were asked to respond to each of the seventeen objective statements of technology education based on the 5-point Likert scale. A one-way analysis of variance was used to test for significant differences in the means for these objective statements among the three department groups. The objective statement, mean, standard deviation, and value and significance of the one-way analysis of variance are presented in Table 6.

The results of the study indicated that significant differences among the three groups existed only on one objective statement that is to develop safe working practices. Further analysis by Scheffé's technique revealed that the TE group had a significantly lower rating toward developing safe working practices than the other two groups. The results showed that (1) the responses of the three subject groups on the objectives of technology education were very consistent except the objective statement indicated above; (2) the objective statements related to technological literacy were rated very highly among the three subject groups; (3) the orders of ranking based on the group means were almost identical among the three subject groups; and (4) the main objectives of traditional industrial arts such as developing basic skills in tools and machines, developing consumer knowledge and appreciation, and providing pre-vocational experiences became less important in the technology education programs.

Problems of technology education

The problems confronting technology education programs were with regard to four factors: a teacher factor, an enrollment factor, a teaching content factor, and a facility factor.

Table 6. Mean, standard deviation, and results of the One-way analysis of variance for objective statements of technology education among the three subject groups

Objective Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Develop problem-solving and decision-making skills involving human, material sources, processes, and technological systems						
	Total	119	4.72	.58	.180	.836
2. Develop an understanding of the nature and characteristics of technology						
	Total	119	4.57	.60	1.750	.178
3. Prepare individuals for intelligent participation as informed citizens in a technological society						
	Total	119	4.51	.65	.801	.451
4. Prepare students for a lifelong learning in a technological society						
	Total	119	4.41	.71	.550	.577
5. Establish beliefs and values based upon the impact of technology and how it alters environments						
	Total	119	4.18	.81	.534	.588
6. Enable individuals to better control their own and society's destiny						
	Total	119	4.13	.91	.032	.968
7. Interpret the evolution and relationships of society, industry, and technical means						
	Total	119	4.03	.89	1.161	.317
8. Provide opportunities to identify aptitudes, abilities, and interest meaningful to career selection						
	Total	119	3.99	.91	.919	.401

Table 6. (continued)

Objective Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
9. Develop safe working practices						
	1	19	3.42	1.17	4.78	.010**
	2	51	4.18	.84		
	3	49	4.00	.87		
	Total	119	3.98	.94		
10. Discover and develop creative technical talents in students						
	Total	119	3.96	.92	1.110	.334
11. Make all students technologically literate, principally as consumers rather than as producers						
	Total	119	3.92	1.00	.960	.386
12. Provide opportunities for reinforcement of content learned in other subject areas						
	Total	119	3.91	.92	.625	.537
13. Develop consumer knowledge and appreciation of industrial products						
	Total	119	3.61	.94	.347	.708
14. Develop basic skills in the use of common tools and machines						
	Total	119	3.54	1.10	1.369	.259
15. Provide pre-vocational experiences						
	Total	119	3.13	1.12	.213	.809
16. Develop recreational and avocational interests						
	Total	119	2.81	1.21	.159	.853

** Significant at the $P < .01$ level.

Table 6. (continued)

Objective Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
17. Provide vocational training						
	Total	118	1.98	1.25	1.626	.201

<u>Teacher factor</u> Subjects respond to nine problem statements concerning the teacher factor. The mean, standard deviation, and one-way analysis of variance of the subjects' responses are summarized in Table 7.

Based on the results of the one-way analysis of variance, no significant difference existed among the three survey groups on any of the problem statements concerning a teacher factor. This implies that the perception of the three subject groups toward TE teacher problems was very consistent. On the basis of gross means of the rating, a serious shortage of qualified TE teachers in the secondary schools was the most serious teacher problem facing the profession, followed by serious competition for student sources with industrial technology programs, university administrator's inadequate understanding of the purpose of TE teacher education, and the lack of effective recruitment strategies in TE teacher education programs. The problem of the TE teacher leaving teaching for industry positions and

Table 7. The mean, standard deviation, and one-way analysis of variance for the problems on the teacher factor

Problem Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. The secondary schools will face a serious shortage of qualified TE teachers during the coming decade						
	Total	120	4.40	.76	.140	.868
2. TE teacher preparation programs will face serious competition for student sources with industrial technology programs						
	Total	120	4.35	.88	1.340	.266
3. University administrators do not understand adequately the purpose of TE teacher education						
	Total	120	4.16	.99	.566	.570
4. TE teacher preparation programs continue to lack effective recruitment strategies						
	Total	120	4.03	1.00	.646	.526
5. TE teachers lack administrative support on their campuses						
	Total	120	3.79	1.10	.002	.998
6. More TE teacher preparation programs will be eliminated from colleges/universities within the coming decade						
	Total	120	3.72	1.06	.126	.882
7. TE teacher preparation programs will experience a dramatic enrollment decline						
	Total	120	3.57	1.14	.134	.875
8. A high percentage of TE teachers will leave teaching for industry positions						
	Total	120	3.35	1.07	.390	.678

Table 7. (continued)

Problem Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
9. The majority of graduates from TE teacher preparation programs go into industry						
	Total	119	3.09	1.24	1.517	.224

pursuing a career in industry by a majority of graduates from TE teacher education programs was less of a concern to the respondents.

<u>The enrollment factors in the secondary schools</u> There were seven problem statements regarding enrollment in IA/TE courses in the secondary schools. Mean, standard deviation, and the one-way analysis of variance of the subject's responses are presented in Table 8.

The one-way analysis of variance was used to test for significant differences of means for enrollment problems among the three subject groups. No significant difference was found in the seven enrollment problem statements. The enrollment problems of TE courses in the secondary schools which most concerned the respondents were "school administrators do not understand TE courses adequately," followed by "parents do not understand TE courses," and "TE curriculum is not a part of the mandatory courses in the

Table 8. The mean, standard deviation, and one-way analysis variance for the problems on TE enrollment in the secondary schools

Problem Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. School administrators do not understand TE courses adequately						
	Total	120	4.18	.95	.342	.711
2. Parents do not understand TE courses						
	Total	120	4.17	.84	.475	.623
3. TE curriculum is not a part of the mandatory courses in the secondary schools						
	Total	119	4.13	1.07	.667	.515
4. TE programs lack effective student recruitment strategies						
	Total	120	4.08	.95	.241	.787
5. The emphasis of the back-to-basic movement leaves no room for elective subjects including TE in the secondary achools						
	Total	120	3.64	1.20	.560	.573
6. The shortage of qualified teachers causes the closing of many TE programs in the secondary schools						
	Total	120	3.40	1.18	.663	.517
7. There is a sharp drop in the secondary school population						
	Total	119	2.95	.96	.044	.957

secondary schools." A sharp drop in the secondary school population and the closing of TE programs due to a shortage of qualified teachers were rated less important in view of enrollment decreases in TE courses.

The teaching content factor in TE programs Four problem statements concerning teaching content in industrial arts/technology education programs were listed in the questionnaire. Mean, standard deviation, and the result of one-way analysis of variance are reported in Table 9.

Table 9. The mean, standard deviation, and one-way analysis of variance for the teaching content problems of technology education programs

Problem Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. There is a marked difference between the implied scope of knowledge and study and the actual activity and results due to facility and time constraints						
	Total	118	3.67	.98	.201	.828
2. The scope of content represented in all teaching areas can not be included in a given curriculum						
	Total	118	3.03	1.23	.046	.955
3. TE programs lack a rational basis for selecting specific technological categories						
	Total	120	2.64	1.26	1.62	.202
4. TE programs lack a recognized body of knowledge and have no well-defined content base						
	Total	119	2.57	1.34	1.449	.239

No significant difference was found among the three survey groups in any of the four teaching content problems. The problem regarding the difference between the implied scope of knowledge and study, and the actual activity and results due to facility and time constraints was rated higher than the other three problems. The means of the responses suggested that the respondents were less concerned with the problems in teaching contents than with those in the teacher, enrollment, and facility factors.

Facility problems in TE programs Two problem statements concerning facility were given. The mean, standard deviation, and result of one-way analysis of variance are presented in Table 10. No significant difference was found in these two facility problem statements among the three subject groups. The grand means for these two facility problem statements were almost the same, 3.70 and 3.69, respectively.

Solutions of the technology education problems

The feasible solutions to the problems confronting technology education programs were investigated in the following four aspects: teacher factor, enrollment factor, teaching content factor, and facility factor.

Table 10. The mean, standard deviation, and one-way analysis of variance for the facility problems

Problem Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. TE programs lack standard facilities to support a wider variety of technological activities						
	Total	120	3.70	1.04	.945	.392
2. TE programs lack adequate facilities and equipment to reflect ongoing technological change to stay current						
	Total	120	3.69	1.16	1.090	.339

Feasible solutions to TE teacher problems Eight possible solutions for solving TE teacher problems were suggested in the questionnaire and judged by the respondents. The mean, standard deviation, and result of one-way analysis of variance of these rated solutions are reported in Table 11.

Based on the results of the one-way analysis of variance, no significant difference was found among the three survey groups on eight feasible solutions to the TE teacher problems. The grand means for the solution statements ranged from 4.20 to 4.72 based on the 5-point Likert scale. This indicated that the respondents agreed very well with the suggested solutions to the TE teacher problems. Providing in-service training for TE teachers was

Table 11. The mean, standard deviation, and one-way analysis of variance for the feasible solutions to the TE teacher problems

Solution Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Provide in-service training for TE teachers						
	Total	119	4.72	.52	.145	.865
2. Develop a comprehensive public information campaign involving all agencies, associations, and media which would be geared to the general public as well as to students and teachers in the secondary schools						
	Total	119	4.60	.62	.047	.954
3. Develop an effective prospective teacher recruitment strategy involving TE teacher, guidance counselor, and university faculty						
	Total	119	4.54	.64	.972	.382
4. Expand and include a wide variety of technological processes for all prospective TE teachers						
	Total	118	4.52	.64	.136	.873
5. Upgrade TE teacher education programs						
	Total	119	4.50	.66	.025	.975
6. Aim recruitment efforts at all age levels of students						
	Total	119	4.48	.71	.366	.694
7. Aid prospective TE teachers by enabling them to understand the potential sociological, economic, aesthetic, environmental, ethical, and political effects of technological change so these could be illustrated clearly to future students						
	Total	118	4.42	.75	.019	.981
8. Recruit prospective teachers from minority and female populations						
	Total	119	4.20	.94	1.094	.338

rated highest among the feasible solutions, followed by developing a comprehensive public information campaign to the general public, students, and teachers in the secondary schools, and developing an effective prospective teacher recruitment strategy.

<u>Feasible solutions to enrollment problems</u> There were nine feasible solution statements to the enrollment problems of TE courses in the secondary schools. The mean, standard deviation, and one-way analysis of variance of the subject's responses to these solution statements are reported in Table 12.

The results of the one-way analysis of variance indicated that no significant difference was found among the three survey groups with the nine solution statements for the TE enrollment problems in the secondary schools. The grand means for the solution statements ranged from 4.37 to 4.67 on the 5-point Likert scale. The nine suggested solutions to the TE enrollment problems in the secondary schools were rated very highly by the respondents. Improving public awareness and support was judged the highest among the possible solutions, followed by drawing support of parents, teachers, counselors, and other adult figures, and establishing relationships with the community beyond the school.

Table 12. The mean, standard deviation, and the one-way analysis of variance for the solutions to the enrollment problems in the secondary schools

Solution Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Improve public awareness and support						
	Total	119	4.69	.56	.565	.569
2. Draw support of parents, teachers, counselors, and other adult figures who might influence student opinion						
	Total	119	4.67	.54	.071	.932
3. Establish relationships with the community beyond the school where understanding and support must be achieved						
	Total	119	4.61	.58	.057	.945
4. Develop relationships within schools aimed at a broader involvement of the other disciplines						
	Total	119	4.57	.61	.203	.817
5. Develop a form of quality technology education appropriate for the whole range of school population						
	Total	119	4.50	.66	.893	.412
6. Improve the ambiance of facilities and safety						
	Total	118	4.41	.87	.306	.737
7. Recruit student leaders, talented and gifted students, and athletes						
	Total	119	4.38	.77	.185	.831
8. Move away from a craft-dominated program to one that centers on technology education						
	Total	119	4.37	.94	.673	.512
9. Recruit more female students						
	Total	119	4.34	.86	.327	.722

Feasible solutions to the teaching content problems

Five possible solutions aimed at teaching content problems in TE courses were suggested in the questionnaire and judged by the respondents. The mean, standard deviation, and result of the one-way analysis of variance for the solutions to teaching content problems are reported in Table 13.

Table 13. The mean, standard deviation, one-way analysis of variance for the solutions to teaching content problems

Solution Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Develop a form of TE that will have a strong experiential base where theory and practice come together to provide an increased understanding and meaningful involvement with technology						
	Total	119	4.50	.75	.216	.806
2. Develop and improve model technology education programs						
	Total	119	4.49	.75	.814	.446
3. Expand curriculum resources						
	Total	119	4.49	.62	.055	.946
4. Redefine the content, programs, and practices so they will reflect the contemporary and future concepts of technology education						
	Total	119	4.42	.79	.168	.846
5. Research and develop new/improved instructional delivery systems						
	Total	119	4.35	.79	.202	.817

Results of the one-way analysis of variance showed that no significant difference was found among the three subject groups in the five feasible solution statements to the teaching content problems. The grand means to the solution statements ranged from 4.35 to 4.49. The action for developing a strong experiential base curriculum was the top rated solution to the teaching content problems, followed by developing and improving model technology education programs, and expanding curriculum resources.

<u>Feasible solutions for the facility problems</u> Six possible solutions toward facility problems in TE programs were included in the survey questionnaire. The mean, standard deviation, and result of one-way analysis of variance for these solution statements are presented in Table 14.

A significant difference was found among the three subject groups on two solution statements: orient the TE labs around the clusters of production, construction, transportation, and communication; and develop a facility standard for facility planning and renovation. Further analysis by Scheffé's technique indicated that the TE/IT/VT group rated this solution statement significantly higher than the TE group. The grand means to these solution statements ranged from 4.06 to 4.55. Among the three top-

Table 14. The mean, standard deviation, and the one-way analysis of variance for the solutions to facility problems

Solution Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Provide assistance for optimum use of existing facilities in locales where economic conditions do not permit a major overhaul of laboratories or equipment						
	Total	118	4.55	.61	.431	.650
2. Develop a total facility and curriculum plan to teach a technology based program						
	Total	119	4.35	.84	.694	.502
3. Replace old, large, and single purpose equipment with a computer and versatile equipment						
	Total	119	4.25	.97	1.608	.205
4. Modify the existing unit-shop to teach a technology-based general lab						
	Total	119	4.21	.947	.142	.868
5. Orient the TE labs around the clusters of production (manufacturing), construction, transportation, and communication						
	1	19	3.47	1.02	5.55	.005**
	2	51	4.29	1.02		
	3	49	4.24	.85		
	Total	119	4.14	.99		
6. Develop a facility standard for facility planning and renovation						
	1	19	3.58	1.07	3.087	.049*
	2	51	4.10	.99		
	3	49	4.20	.84		
	Total	119	4.06	.96		

* Significant at the $P < .05$ level.
** Significant at the $P < .01$ level.

rated solutions to the facility problems were providing assistance for optimum use of existing facilities (4.55), developing a total facility and curriculum plan to teach a technology-based program (4.35), and replacing old, large, and single-purpose equipment with a computer and versatile equipment (4.25).

<u>Prospects of technology education</u>

Thirteen statements concerning prospects of technology education were included in the survey questionnaire. The mean, standard deviation, and results of the one-way analysis of variance for these prospect statements among the three groups are presented in Table 15.

The results of the one-way analysis of variance indicated that only one prospect statement, "the scope of content will reflect the concepts of technology education," was found significantly different among the three subject groups. Further analysis by Scheffé's technique revealed that the TE group had a significantly positive attitude toward the scope of technology education than the TE/IT group. The grand means of these prospect statements ranged from 2.67 to 3.84. In general the respondents were not optimistic about the prospect of technology education

Table 15. The mean, standard deviation, and the one-way analysis of variance for the prospects of technology education

Prospect Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Job opportunities for graduates from TE teacher programs will remain strong						
	1	19	4.26	.734	3.755	.026*
	2	53	3.62	.99		
	3	48	3.94	.91		
	Total	120	3.85	.94		
2. The scope of content will reflect the concepts of technology education						
	Total	119	3.84	.83	.175	.839
3. The image of TE teacher education programs will get better						
	Total	120	3.81	.94	.767	.467
4. Quality of TE teacher in secondary schools will improve						
	Total	120	3.78	.79	.284	.754
5. Image of TE programs in the secondary schools will improve						
	Total	118	3.66	.90	.313	.732
6. The TE teacher's starting salary will remain competitive						
	Total	119	3.41	1.07	1.163	.316
7. Enrollment of TE programs in the secondary schools will increase						
	Total	120	3.38	.98	.549	.579
8. Administrators's support for TE programs in the secondary schools will grow						
	Total	120	3.34	.99	.303	.740

* Significant at the P < .05 level.

Table 15. (continued)

Prospect Statement	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
9. A well-defined curriculum standard will be available and widely adopted						
	Total	119	3.27	1.05	.295	.745
10. A well-defined facility standard will be available and widely adopted						
	Total	119	2.91	1.10	.240	.787
11. Enrollment in TE teacher education programs will increase						
	Total	120	2.89	.99	.306	.737
12. Equipment acquisition for TE programs will be well funded in the secondary schools						
	Total	120	2.78	1.08	.005	.995
13. The number of TE faculty in colleges/universities will grow						
	Total	120	2.67	1.01	.146	.864

programs. Among the three top-rated prospects of technology education were that job opportunities for graduates from TE teacher programs will remain strong (3.85), the scope of content will reflect the concepts of technology education (3.84), and the image of TE teacher education programs will get better (3.81). The respondents gave the most pessimistic response to the number of TE faculty in colleges/universities (2.67) and funding for equipment acquisition in the secondary schools (2.78).

Factor Analysis

The single most distinctive characteristic of factor analysis is its data-reduction capability. Factor-analytic techniques can be used to examine whether some underlying pattern of relationships exists such that the data may be rearranged or reduced to a smaller set of factors or components that may be taken as source variables accounting for the observed interrelations in the data. The factor analysis technique was used to derive factors for the items containing objective, problem, solution of problem, and prospect of technology education.

Philosophical objectives of technology education

Seventeen objective statements of industrial arts/technology education were included in the factor analysis. Four factors were selected from the factor matrix for varimax rotation. A total of 59.3 percent of total variation was accounted by these four factors. There were 6 items which were included in factor #1, 6 items in factor #2, 3 items in factor #3, and 2 items in factor #4. These four factors were labeled as: (1) technological literacy, (2) conventional IA objective, (3) intellectual development, and (4) use of tools and machines. Items in each factor were then carefully examined. Items with low loadings in each factor were not used to measure the factors. No item in this analysis had loading less than .50. Therefore, all items were included in the analysis.

Problems of technology education

Twenty-two problem statements concerning industrial arts/technology education were included in this factor analysis. Seven factors were selected from the factor matrix for varimax rotation. A total of 66.6 percent of total variation was accounted for by these seven factors. There were 4 items which were included in factor #1, 3 items in factor #2, 4 items in factor #3, 2 items in factor #4, 2 items in factor #5, 4 items in factor #6, and one item in factor #7. Factor #7 was excluded in the analysis, since it only consisted of one item. The remaining six factors for the problems of technology education were labeled as: (1) teaching content, (2) perception of program, (3) teacher education program, (4) student recruitment, (5) facility, and (6) teacher shortage.

Items with low loadings in each factor were not included on any of the factors. No item was discarded for factors #1 through #5. Items 10 and 12 were not included in factor #6 due to either low loading value or content invalidity with other items included in the factor. Table 17 presents a summary of factor analysis for the TE problems.

Table 16. Factor analysis for objectives of technology education

Objective statement	Factor loading
Factor #1: Technological literacy	
15. Prepare student for lifelong learning in a technological society	.78
17. Enable individuals to better control their own and society's destiny	.77
14. Prepare individuals for intelligent participation as informed citizens in a technological society	.73
13. Establish beliefs and values based upon the impact of technology and how it alters environments	.70
1. Develop an understanding of the nature and characteristics of technology	.64
16. Make all students technologically literate, principally as consumers rather than as producers	.57
Factor #2: Conventional IA objective	
7. Provide pre-vocational experiences	.69
10. Provide opportunities to identify aptitudes, abilities, and interest meaningful to career selection	.68
5. Develop recreational and avocational interests	.67
3. Develop consumer knowledge and appreciation of industrial products	.65
11. Provide opportunities for reinforcement of content learned in other subject areas	.59
8. Provide vocational training	.58

Table 16. (continued)

Objective statement	Factor loading
Factor #3: Intellective development	
9. Develop problem-solving and decision-making skills involving human, material sources, processes, and technological systems	.81
6. Discover and develop creative technical talents in students	.63
12. Intepret the evolution and relationships of society, industry, and technical means	.56
Factor #4: Use of tools and machines	
4. Develop safe working practices	.76
2. Develop basic skills in the use of common tools and machines	.73

Solutions of technology education problems

Twenty-eight possible solutions for TE problems were included in this factor analysis. Seven factors were selected from the factor matrix for varimax rotation. A total of 66.1 percent of total variation was accounted for by these seven factors. A factor containing items 6, 7, and 24 in this section with low loadings was discarded in the further analysis. The remaining six factors of solutions for solving TE problems were labeled as (1) curriculum development, (2) public relations, (3) teacher education, (4) prospective teacher recruitment, (5) female student recruitment, and (6) facility and instruction renovation.

Table 17. Factor analysis for problems of technology education

Problem statement	Factor loading
Factor #1: Teaching content	
18. The scope of content represented in all teaching areas can not be included in a given curriculum	.79
17. TE programs lack a recognized body of knowledge and have no well-defined content base	.75
20. TE programs lack a rational basis for selecting specific technological categories	.73
19. There is a marked difference between the implied scope of knowledge and study, and the actual activity and results due to facility and time constraints	.73
Factor #2: Perception of program	
13. School administrators do not understand TE courses adequately	.80
4. University administrators do not understand adequately the purpose of TE teacher education	.73
14. Parents do not understand TE courses	.70
Factor #3: Teacher education program	
2. The majority of graduates from TE teacher preparation programs go into industry	.77
7. A high percentage of TE teachers will leave teaching for industry positions	.75
6. TE teacher preparation programs will experience a dramatic enrollment decline	.64
3. More TE teacher preparation programs will be eliminated from colleges/universities within the coming decade	.59

Table 17. (continued)

Problem statement	Factor loading
Factor #4: Student recruitment	
8. TE teacher preparation programs continue to lack effective recruitment strategies	.90
15. TE programs lack effective student recruitment strategies	.76
Factor #5: Facility	
22. TE programs lack standard facilities to support a wider variety of technological activities	.84
21. TE programs lack adequate facilities and equipment to reflect ongoing technological change to stay current	.80
Factor #6: Teacher shortage	
11. The shortage of qualified teachers causes the closing of many TE programs in the secondary schools	.67
1. The secondary schools will face a serious shortage of qualified TE teachers during the coming decade	.56

Item 28 in factor #1 was not included in the further analysis due to their low loadings in the factors. Table 18 presents a summary of factor analysis for solutions to TE problems.

Table 18. Factor analysis for solutions to TE problems

Solution statement	Factor loading
Factor #1: curriculum development	
27. Develop a total facility and curriculum plan to teach a technology-based program	.78
23. Modify the existing unit-shop to teach a technology-based general lab	.77
26. Replace old, large, and single purpose equipment with computers and versatile equipment	.76
10. Move away from a craft-dominated program to one that centers on technology education and is attractive to all students	.67
8. Aid prospective TE teachers by enabling them to understand the potential sociological, economic, aesthetic, environmental, ethical, and political effects of technological change so that these could be illustrated clearly to future students	.57
25. Develop a facility standard for facility planning and renovation	.57
22. Develop a form of TE that will have a strong experiential base wherein the theory and practice come together to provide increased understanding and meaningful involvement with technology	.49
Factor #2: Public relations	
13. Draw support of parents, teachers, counselors, and other adult figures who might influence student opinion	.81
11. Improve public awareness and support	.70
17. Establish relationships with the community beyond the school where understanding and support must be achieved	.68
14. Recruit student leaders, talented and gifted students, and athletes	.60

Table 18. (continued)

Solution statement	Factor loading
Factor #3: Teacher education	
19. Develop and improve model technology education programs	.77
21. Expand curriculum resources programs	.63
18. Redefine the content, programs, and practices so that they will reflect the contemporary and future concepts of technology education	.56
9. Develop a form of quality technology education appropriate for the whole range of school population	.51
Factor #4: Perspective teacher recruitment	
2. Develop an effective perspective teacher recruitment strategy involving TE teacher, guidance counselor, and university faculty	.81
3. Develop a comprehensive public information campaign involving all agencies, associations, and media which would be geared to the general as well as to secondary students and teachers	.70
4. Aim recruitment efforts at all age levels of students	.66
1. Upgrade TE teacher education program	.61
Factor #5: Female student recruitment	
12. Recruit more female students	.79
5. Recruit perspective teachers from minority and female populations	.73
Factor #6: Facility and instruction renovation	
15. Improve the ambiance of facilities such as laboratory ventilation and brightness and safety	.75

Table 18. (continued)

Solution statement	Factor loading
16. Develop relationships within school aimed at a broader involvement of the other disciplines	.58
20. Research and develop new/improved instructional delivery systems	.57

Prospects of technology education

Thirteen statements regarding prospects of industrial arts/technology education were included in the factor analysis. Three factors were selected from the factor matrix for varimax rotation. A total of 69.9 percent of the variance was accounted for by these three factors. The three factors for the prospects of technology education were labeled as (1) program quality and image, (2) facility and curriculum, and (3) graduates and enrollment. There were 5 items which were included in factor #1, 5 items in factor #2, and 3 items in factor #3. No item was discarded in the analysis of this section. Table 19 reports a summary of factor analysis for prospects of technology education.

Derived factors were used for hypothesis testing in the following section. The factor scores were formed by simple linear composites of items loading highly in a factor. That is, a factor score was defined as the mean of the item scores.

Table 19. Factor analysis for the prospects of technology education

Prospect statement	Factor loading
Factor #1: Program quality and image	
9. Image of TE programs in the secondary schools will improve	.81
10. The scope of content will reflect the concepts of technology education	.79
6. Quality of TE teachers in the secondary schools will improve	.78
8. Administrators' support for TE programs in the secondary schools will grow	.64
4. The image of TE teacher education programs will improve	.62
Factor #2: Facility and curriculum	
13. A well-defined facility standard will be available and widely adopted	.86
12. Equipment acquisition for TE programs will be well funded in the secondary schools	.78
5. The number of TE faculty in colleges/universities will grow	.69
11. A well-defined curriculum standard will be available and widely adopted	.68
1. Enrollment in TE teacher education programs will increase	.55
Factor #3: Graduates and enrollment	
2. Job opportunities for graduates from TE teacher education programs will remain strong	.82
3. The TE teachers' starting salary will remain competitive	.69
7. Enrollment of TE programs in the secondary schools will increase	.50

Hypothesis Testing

There were eight research hypotheses to be tested in this section.

Research hypothesis 1

It was hypothesized that the means for philosophical objectives of technology education are equal among the three survey groups (TE, TE/IT, and TE/IT/VT).

The department chairpersons were asked to respond to each of the seventeen objective statements of technology education based on the 5-point Likert scale. These seventeen items were reduced to four objective factors by the factor analysis technique. The one-way analysis of variance was used to test for significant differences of means for these objective factors among the three survey groups. The objective factor, mean, standard deviation, and F value and significance of each one-way analysis of variance are presented in Table 20.

The results of the one-way analysis of variance indicated that significant differences among the three groups existed only for one objective factor, namely, the use of tools and machines. Further analysis by Scheffé's technique revealed that the TE group had a significantly lower rating toward the use of tools and machines as the TE

Table 20. The mean, standard deviation, and results of the one-way analysis of variance for objective factors of technology education among the three subject groups

Objective Factor	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	F-ratio Significance
1. Technological literacy						
	Total	119	4.29	.56	.458	.634
2. Conventional IA objective						
	Total	118	3.23	.72	.398	.672
3. Intellectual development						
	Total	119	4.24	.60	.289	.750
4. Use of tools and machines						
	1	19	3.29	1.16	3.325	.039*
	2	51	3.89	.81		
	3	49	3.81	.84		
	Total	119	3.76	.90		

* Significant at the $P < .05$ level.

objective than the other two groups. The results showed that (1) the responses of the three survey groups regarding the objectives of technology education were very consistent except on one objective factor indicated above, (2) both technological literacy (4.29) and intellectual development (4.24) factors were rated higher than the factor on use of tools and machines (3.76) and conventional IA objective (3.23), and (3) the conventional IA objectives including developing basic skills in tools and machines, developing consumer knowledge and appreciation, and providing pre-vocational experiences became less important in the technology education programs.

Research hypothesis 2

It was hypothesized that the means for problems confronting technology education programs are equal among the three survey groups.

The twenty-two problem items were rearranged into six problem factors by the factor analysis technique. Then, the one-way analysis of variance was used to test for significant differences of means for these problem factors among the three survey groups. Table 21 reports mean, standard deviation, and F value and significance of each one-way analysis of variance for these problem factors.

Based on the results of one-way analysis of variance, no significant difference existed among the three survey groups on any of the six problem factors. This implied that the perception of the three survey groups toward the problems involved in technology education programs was very uniform and consistent. On the basis of the gross means of the rating, the factor involving the perception of technology education (4.17) among parents, administrators, and the public was the most serious problem facing the TE profession, followed by student recruitment (4.05), teacher

Table 21. The mean, standard deviation, and results of the one-way analysis of variance for problem factors of technology education among the three subject groups

Problem Factor	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Teaching content						
	Total	117	2.98	.94	.698	.500
2. Perception of program						
	Total	120	4.17	.78	.094	.911
3. Teacher education program						
	Total	119	3.43	.85	.188	.829
4. Student recruitment						
	Total	120	4.05	.89	.412	.663
5. Facility						
	Total	120	3.70	1.04	1.150	.321
6. Teacher shortage						
	Total	120	3.90	.78	.180	.835

shortage (3.90), and facility (3.70) factors. The problems over the teaching content factor were of less concern to the respondents.

Research hypothesis 3

It was hypothesized that the means for possible solutions to problems confronting technology education programs are equal among the three survey groups.

Twenty-eight possible solutions for solving technology education problems were suggested in the survey questionnaire and judged by the research subjects. Six solution factors were derived from the factor analysis. The one-way analysis of variance was employed to test for significant differences of means for these solution factors among the three survey groups. The solution factor, mean, standard deviation, and F value and significance of the one-way analysis of variance for these solution factors are presented in Table 22.

The results of one-way analysis of variance revealed that there was no significant difference among the three survey groups on any of the six solution factors of the technology education. The rating of the respondents on all the six solution factors was very consistent among the three subject groups. The grand means of the solution factors ranged from 4.27 to 4.60, based on the 5-point Likert scale. This indicated that the respondents agreed very favorably to the suggested solutions to the technology education problems. Improving public relations (4.60) was rated highest among the solution factors, followed by recruiting prospective students (4.53), improving teacher education (4.47), renovating facility and instruction (4.43), and developing relevant curriculum (4.32). The female student

Table 22. The mean, standard deviation, and results of the one-way analysis of variance for solution factors of of technology education among the three subject groups

Solution Factor	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	Significance
1. Curriculum development						
	Total	118	4.32	.62	.365	.695
2. Public relations						
	Total	118	4.60	.51	.036	.965
3. Teacher education						
	Total	119	4.47	.55	.106	.899
4. Prospective student recruitment						
	Total	119	4.53	.50	.284	.753
5. Female student recruitment						
	Total	117	4.27	.82	.410	.665
6. Facility and instruction renovation						
	Total	119	4.43	.58	.016	.984

recruitment (4.27) was rated the lowest among the solution factors.

Research hypothesis 4

It was hypothesized that the means for prospects of technology education are equal among the three survey groups.

Thirteen prospect statements concerning technology education were included in the survey questionnaire and judged by the three survey groups. Three prospect factors were deduced from these thirteen items from the factor analysis. The one-way analysis of variance was used to test for significant differences of means for these prospect factors among the three survey groups. Table 23 reports prospect factor, mean, standard deviation, and F value and significance of one-way analysis of variance for these prospect factors.

Table 23. The mean, standard deviation, and results of the one-way analysis of variance for prospect factors of technology education among the three survey groups

Prospect Factor	Group	No. of Obs.	Mean	Standard Deviation	F-ratio Value	F-ratio Significance
1. Program quality and image						
	Total	117	3.69	.74	.131	.878
2. Facility and curriculum						
	Total	119	2.91	.84	.005	.995
3. Graduates and enrollment						
	Total	119	3.55	.80	2.316	.103

No significant difference was found among the three survey groups on all three prospect factors. This indicated that the perception of technology education prospects was very consistent among the three survey groups. The grand means of these three prospect factors ranged from 2.91 to 3.69, which were quite low. These low ratings indicated that the department chairpersons were somewhat pessimistic about the prospects of technology education. The rating of prospects concerning TE program quality and image (3.69) was higher than those for the graduate and enrollment factor (3.55), and the facility and curriculum factor (2.91).

Research hypothesis 5

It was hypothesized that the selected independent variables do not contribute to the prediction of subjects' perception of the four philosophical objective factors of technology education.

The stepwise multiple regression technique was used for testing the correlations between each of the four philosophical objective factors and the selected independent variables.

The independent variables selected to test this hypothesis were enrollment trends of the TE program, enrollment trends of the IT program, percentages of the TE graduates' employment in teaching during 1981-82, and during 1986-87, respectively, graduates' starting salary for teaching, graduates' starting salary for working in industry, percentage of faculty with a specialty in TE, curriculum emphasis in 1986-87, perception of technological impact, and technology adaptation.

Table 24 summarizes the results of significant predictors for these four philosophical objective factors of technology education. Variables entered in the regression model, the values of B, Beta, R-square, intercept, as well as the value and significance of the F-ratio are presented in the table. B is the unstandardized regression coefficients. Beta is the partial regression coefficients. Constant is the intercept of the regression equation. The values of the regression coefficients are those obtained for the final step in the computations, where all eligible variables have been entered into the regression equation. The value and significance of F-ratio present the information relevant to a test for R-square, the overall test for goodness of fit of the regression equation.

The results indicated that no variable was significantly correlated for entering into the regression models for one dependent variables, that is the use of tools and machines.

For the technological literacy factor, only technology adaptation was entered into the regression model. The predictor accounted for 8.9 percent of the variance. The result also showed that technology adaptation was

Table 24. Results of the multiple regression for philosophical objective factors

Variable Entered	B	Beta	R Square	F-ratio value	Significance
Factor: Technological literacy					
Technology adaptation	.275	.299	.089	4.604	.037*
(Constant)	3.318				
Factor: Conventional IA objective					
Salary for teaching	-.088	-.302	.091	4.714	.035*
(Constant)	4.831				
Factor: Intellectual development					
Teaching percentage in 1981-82	.006	.290	.084	4.330	.043*
(Constant)	3.880				
Factor: Use of tools and machines					
No variable was significantly correlated with this factor					

* Significant at the $P < .05$ level.

significantly correlated with the technological literacy factor.

For the conventional IA objective factor, only one variable, salary for teaching, was entered into the regression model. The R-square coefficient resulting from this predictor was .091, which shows that salary accounted for 9.1 percent of the variance in this factor. The results also indicated that the conventional IA objective factor was found significant and negatively correlated with salary for teaching. This means that the higher the salary TE graduates earned from teaching, the less the rating value of the conventional IA objective factor given by the respondents.

For the intellectual development factor, one independent variable, teaching percentage in 1981-82, was significant and entered into the regression model. The predictor accounted for 8.4 percent of the variance of the factor. The results also revealed that the teaching percentage in 1981-82 was significantly correlated with the intellectual development factor.

Research hypothesis 6

It was hypothesized that the selected independent variables do not contribute to the prediction of subjects' perception of the six problem factors of technology education.

The same set of independent variables selected to test hypothesis 5 was also used for this hypothesis testing. The stepwise multiple regression technique was used for testing the correlations between the six problem factors and the selected independent variables.

Table 25 summarizes the results of the multiple regression analysis and also presented the significant predictors and their contribution to the prediction of each of the problem factors.

The results indicated that no independent variable was significantly correlated to be entered into the regression models for the teaching content factor. This means that no variable met the .05 significance level for entry into the model.

For the perception of technology education factor, one predictor variable, curriculum emphasis in 1986-87, was significant and entered into the regression model. The predictor accounted for 8 percent of the variance in the perception of technology education factor.

For the teacher education program factor, two variables, enrollment trends of TE program and graduates' employment in teaching in 1986-87, were entered into the regression model. The R-square coefficient resulting from these two predictors was .231, which indicated that they accounted for 23.1 percent of the variance in that factor. The results also revealed that both graduates' employment percentage in teaching in 1986-87 and the enrollment trends of the TE program were significant and negatively correlated with the teacher education program factor.

For the student recruitment factor, one predictor variable (enrollment trends of the IT program) was

Table 25. Results of the multiple regression for problem factors

Variable Entered	B	Beta	R Square	F-ratio value	Significance
Factor: Teaching content					
No variable was significantly correlated with this factor					
Factor: Perception of TE program					
Curriculum emphasis in 1986-87	.423	.283	.080	4.080	.049*
(Constant)	2.507				
Factor: Teacher education program					
Enrollment trends of IT program	-.008	-.351	.231	6.909	.003**
Teaching percentage in 1986-87	-.010	-.283			
(Constant)	3.626				
(Constant)	3.358				
Factor: Student recruitment					
Enrollment trends of TE program	-.002	-.287	.082	4.221	.045*
(Constant)	3.998				
Factor: Facility					
Faculty specialty in TE	-.013	-.330	.109	5.754	.021*
(Constant)	4.150				

* Significant at the P < .05 level.
** Significant at the P < .01 level.

Table 25. (continued)

Variable Entered	B	Beta	R Square	F-ratio value	Significance
Factor: Teacher shortage					
Enrollment for TE major	-.008	-.429	.284	5.960	.002**
Salary for industry	.094	.325			
Graduates' employment in teaching in 1986-87	.008	.276			
(Constant)	1.223				

significantly correlated with this factor and was entered into the regression model. Enrollment trends of the TE program had an R-square coefficient of .082, which indicated this variable accounted for 8.2 percent of the variance in student recruitment. A negative correlation coefficient was found between the student recruitment factor and enrollment trends of the IT program.

The results showed that faculty specialty in TE was significantly and negatively correlated with the facility factor. The contribution of faculty specialty in TE to the R-square coefficient for the facility factor was .109. In other words, faculty specialty in TE accounted for 10.9 percent of the variance in facility factor.

For the teacher shortage factor, three predictor variables: enrollment trend for the TE program, salary in industry, and graduates' employment in teaching in 1986-87, were included in the regression model. As indicated in Table 25, these three predictors accounted for 28.4 percent of the variance of the teacher shortage factor.

Research hypothesis 7

It was hypothesized that the selected independent variables do not contribute to the prediction of the subjects' perception of the six solution factors of technology education.

A stepwise multiple regression analysis was performed to test the correlations between the six solution factors and the selected independent variables. Results of the test are summarized and presented in Table 26.

For the curriculum development factor, the only predictor variable entered into the regression model was technological impact. A significant and positive correlation (.514) was found between the curriculum development factor and technological impact. This implied that the more the technological impact on the TE program was perceived, the greater the need for developing an adequate TE curriculum was rated. This predictor accounted for 26.5 percent of the variance of the curriculum development factor.

Table 26. Results of the multiple regression for solution factors of technology education

Variable Entered	B	Beta	R Square	F-ratio value	Significance
Factor: Curriculum development					
Technological impact	.426	.514	.265	16.908	.000**
(Constant)	2.928				
Factor: Public relations					
Technological impact	.213	.303	.192	5.480	.007**
Faculty specialty in TE	-.006	-.319			
(Constant)	4.133				
Factor: Teacher education					
Technology adaptation	.286	.305	.226	6.723	.003**
Faculty specialty in TE	-.008	-.386			
(Constant)	3.844				
Factor: Prospective student recruitment					
technological impact	.191	.291	.085	4.356	.042**
(Constant)	3.903				
Factor: Female student recruitment					
Technological impact	.527	.451	.203	8.677	.006**
(Constant)	2.460				
Factor: Facility and instruction innovation					
Technological impact	.305	.440	.348	8.013	.000**
Graduates' employment in teaching in 1986-87	-.007	-.347			
Faculty specialty in TE	-.005	-.291			
(Constant)	3.973				

** Significant at the P < .01 level.

Two predictor variables, technological impact and faculty specialty in TE, were included in the regression model for the public relations factor. The R-square coefficient (.192) indicated that technological impact and faculty specialty in TE accounted for 19.2 percent of the variance in public relations.

For the teacher education factor, two predictor variables were significant and were entered into the regression model. These two predictors included technology adaptation and faculty specialty in TE. A combination of these two variables accounted for 22.4 percent of the variance for the teacher education factor.

Concerning the prospective student recruitment, only one predictor variable, technological impact, was selected in the multiple regression analysis. This predictor accounted for 8.5 percent of the variance of the prospective student recruitment factor.

Technological impact was the only predictor variable which was entered into the regression model for female student recruitment. The R-square coefficient was .118, which indicated that the technological impact accounted for 11.8 percent of the variance in female student recruitment.

For the facility and instruction innovation factor, three predictor variables were significant and were entered into the regression model. Technological impact entered into the model first, followed by graduates' employment in teaching in 1986-87 and faculty specialty in TE. A combination of these three variables accounted for 34.8 percent of the variance for the facility and instruction innovation factor.

From the results of the multiple regression test, it can be observed that perception of technological impact was the most common predictor variable for the solution factor to TE problems followed by faculty specialty in TE.

It was also found that faculty specialty in TE was negatively correlated with three solution factors. This implied that the higher the percentage of the faculty specialized in industrial arts/technology education in a department, the lower the rating on solution factors that was given by the department chairperson. This may imply that specialization poses a limitation on the resolution of critical problems facing a department.

Research hypothesis 8

It was hypothesized that the selected independent variables do not contribute to the prediction of subjects' perception of the three prospect factors of technology education.

A stepwise multiple regression analysis was performed to test correlations between the three prospect factors and the selected independent variables. Results of this test are summarized in Table 27.

Table 27. Results of the multiple regression for prospect factor of TE

Variable Entered	B	Beta	R Square	F-ratio value	F-ratio Significance
Factor: Program quality and image					
Curriculum emphasis in 1986-87	.728	.622	.359	12.867	.000**
Enrollment trend for IT major	.002	.427			
(Constant)	1.082				
Factor: Facility and curriculum					
Curriculum emphasis in 1986-87	.454	.347	.200	5.721	.006**
Graduates' employment in teaching in 1986-87	.008	.286			
(Constant)	1.109				
Factor: Graduates and enrollment					
Curriculum emphasis in 1986-87	.684	.499	.231	6.910	.002**
Enrollment for IT major	.002	.343			
(Constant)	1.039				

** Significant at the P < .01 level.

For the program quality and image factor, two predictor variables, curriculum emphasis in 1986-87 and enrollment trends for IT programs, were entered into the regression model. The R-square coefficient resulting from these predictors was 35.9, which accounted for 35.9 percent of the variance in program quality and image.

Two predictor variables were significant and were entered into the regression model for the facility and curriculum factor. The predictor variables in this model included curriculum empahsis in 1986-87 and graduates' employment in teaching in 1986-87. A combination of these two variables accounted for 20.0 percent of the variance for program quality and image factor.

For the graduate and enrollment factor, two predictor variables were significant and were entered into the regression model. Curriculum emphasis in 1986-87 entered into the model first, followed by enrollment trend in IT programs. The R-square coefficient resulting from these two predictors was .231, which accounted for 23.1 percent of the variance for the graduates and enrollment factor.

From the result of the multiple regression test, it can be observed that curriculum emphasis in 1986-87 was the most common predictor variable for the prospect factors of technology education. The other common predictor variable which significantly contributed to the prediction of the prospect factors was enrollment trend for IT programs, which entered into two regression models.

CHAPTER V. A GENERAL REVIEW OF THE STUDY AND RECOMMENDATIONS FOR REFORM

This chapter summarizes the research results from the preceding chapters, draws conclusions based on the findings, and presents some recommendations for program reform.

A General Review of the Study

Restatement of the problem

This study was designed to investigate the trends and issues confronting technology education movement. It also examined selected variables in order to determine if they contribute to the perception of philosophical objectives, problems, solutions of problems, and prospects of technology education programs.

Restatement of the purposes

The purpose of this study was to examine the nature of the current technology education movement, its impacts, problems, and directions, as well as the prospects for technology education programs.

To achieve the purposes of this study, a survey questionnaire was used for collecting the data. The instrument consisted of three parts. The first part contained items concerning industrial arts/technology education program characteristics. The second part listed possible philosophical objectives, problems, and directions of current technology programs. The third part consisted of thirteen questions concerning the prospects of technology education.

To examine if variance for an individual item differentiated among survey groups, chi-square and one-way analysis of variance were conducted to test the equality of item proportions and means by subject groups for discrete and continuous variables, respectively.

Factor analysis was also used to derive factors for the items containing objectives, problems, possible solutions, and prospects of technolgy education. Four orthogonal factors were extracted from the analysis for philosophical objectives of technology education. These four factors were (1) technological literacy, (2) conventional IA objective, (3) intellectual development, and (4) use of tools and machines.

Six factors were derived from the factor analysis for the technology education problems. These six factors were labeled as (1) teaching content, (2) perception of the program, (3) teacher education program, (4) student recruitment, (5) facility, and (6) teacher shortage.

Six factors were also extracted from the analysis for solutions of solving TE problems. They were labeled as (1) curriculum development, (2) public relations, (3) teacher education, (4) prospective teacher recruitment, (5) female student recruitment, and (6) facility and instruction renovation.

For prospects of technology education, three factors were derived from the factor analysis. They were (1) program quality and image, (2) facility and curruculum, and (3) graduates and enrollment.

Scores on the factors for each research subject were computed. Factor scores which were defined as the mean of the item scores loaded on the factor were used for hypothesis testing.

Eight hypotheses were formulated and tested at .05 level of significance. Results pertaining to IA/TE program characteristics, item analysis, and findings related to the eight research hypotheses are summarized and presented in the following section.

Program characteristics

Highest degree offered   About one-half of the departments which offer an IA/TE teacher education program reported that the highest degree their department offers is the master's degree, while 20 percent offers a Ph.D. or an Ed.D. degree, and 28 percent offers only bachelor's degree.

<u>Enrollment trends of IA/TE programs</u> No significant difference was found among the three department groups regarding enrollment trends of the IA/TE programs. Only about 13 percent of the programs experienced an enrollment increase in the 1986-87 school year as compared to 1981-82. More than one-half (58.2%) of the IA/TE programs suffered an enrollment decrease during the same period. Quantitatively speaking, IA/TE programs suffered about a 21 percent enrollment drop in the five year period.

<u>Enrollment trends of IT programs</u> Approximately two-thirds (60%) of the industrial technology programs had an enrollment increase during 1986-87 as compared to 1981-82, while 18 percent of the programs experienced an enrollment decrease. The results also found that IT programs experienced about a 45 percent of enrollment increase in the same five-year period.

<u>IA/TE graduate's employment by category</u> About 60 percent of the IA/TE graduates pursued teaching career, while 36 percent entered industry, and 6 percent were self-employed in 1981-82. However, during 1986-87, about 51% of the IA/TE graduates went into teaching, which dropped 9 percent as compared to 1981-82. About 44 percent of the IA/TE graduates went into industry during 1986-87, which was an 8 percent increase from 1981-82. The results also indicated that more IA/TE graduates (51%) from the TE/IT

department group went into industry than those (30%) from the TE department group.

IA/TE graduate's salary The average starting salary of IA/TE graduates was $17,160 for teaching and $21,430 for working in industry during 1986-87 school year. These figures may be misleading because of graduates taking teaching positions run 10 months versus 12 months in industry.

Faculty's specialty area Significant differences were found among the three survey groups regarding the percentage of the faculty's specialty in IA/TE. About 56 percent of the faculty in the departments surveyed had their specialty area in IA/TE, while 25 percent were in vocational/technical education, and 8 percent were in engineering. The results also showed that the TE department group had a proportionately higher percentage of faculty who had a specialty area in IA/TE than the other two department groups.

Curriculum emphasis The order and weight of IA/TE curriculum emphasis in 1981-82 were professional education (3.73), graphics communication (3.13), manufacturing (3.01), power/energy (2.94), construction (2.91), electronics/computer (2.74), and CAD/CAM/CIM (1.81). Howerver, in 1986-87, the emphasis became professional education (3.78), manufacturing (3.69), CAD/CAM/CIM (3.63), electronics/computer (3.61), graphics communication (3.50), power/energy (3.41), and construction (3.27). It is apparent that shifts occurred in curriculum during the five-year period selected in this study.

Impact of technologies on programs The results indicated that the computer (4.21) had the most significant impact on the IA/TE programs, followed by CAD (3.83), NC/CNC (3.42), robotics (3.33), digital electronics (3.32), tabletop publishing (2.71), and laser (2.22) technologies.

Adaptation of technologies into programs The results showed that the computer (4.21) adapted best into the IA/TE programs, followed by CAD (4.10), NC/CNC (3.50), CAM (3.44), digital electronics (3.35), robotics (3.34), tabletop publishing (2.88), and laser (2.23) technologies.

Item analysis

Philosophical objectives To develop problem-solving and decision-making skills (4.72) was rated highest among the seventeen objective statements of IA/TE, followed by developing an understanding of the nature and characteristics of technology (4.57), preparing individuals for intelligent participation in a technological society (4.51), and preparing students for lifelong learning in a technological society (4.41). The results showed also that the objective statements related to technological literacy were rated very high among the three department groups. The main objectives of traditional IA such as developing basic skills in tools and machines, developing consumer knowledge and appreciation, and providing pre-vocational experiences became less important in the contemporary TE programs.

Problems of technology education No significant difference was found among the three survey groups on all problem statements concerning teacher, enrollment, teaching content, and facility of technology education. This implied that the perception of the three survey groups toward TE problems was very uniform and consistent. The shortage of qualified TE teachers was the most serious teacher problem facing the profession, followed by serious competition for student sources with IT programs, and inadequate understanding of the purposes of TE teacher education by university administrators.

In terms of the enrollment problem of TE courses in secondary schools, "school administrators do not understand TE courses adequately" was the top rated problem, followed by "parents do not understand TE courses," and "TE curriculum is not a part of the mandatory courses in the secondary schools."

For the teaching content problem, the results indicated that the respondents were less concerned with the problems in this respect than those in teacher, enrollment, and facility factors.

Solutions of TE problems   Generally speaking, the respondents agreed very well to the suggested solutions to the TE problems. Providing in-service training for TE teachers was rated highest among the feasible solutions to the teacher problems, followed by developing a public information campaign, and developing an effective perspective teacher recruitment strategy.

In terms of solving enrollment problems in the secondary schools, improving public awareness and support was judged highest among the possible solutions, followed by drawing the support of parents, teachers, and counselors, and establishing relationships with the community beyond the school.

For the teaching content problems, the action for developing a strong experiential base curriculum was the top rated solution, followed by developing and improving model technology education programs, and expanding curriculum resources.

A significant difference was found among the three survey groups on orienting the TE labs around the clusters of production, construction, transportation, and communication. Among the three top-rated solutions to facility problems were providing assistance for optimum use of existing facilities, developing a total facility and curriculum plan to teach a technology based program, and replacing old, large, and single purpose equipment with computers and versatile equipment.

Prospects of technology education The results indicated that the respondents were not optimistic about the prospect of technology education programs. Job opportunities for graduates from TE teacher programs will remain strong (3.85) was the top-rated prospect, followed by the scope of content will reflect the concepts of technology education (3.84), and the image of TE teacher education programs will get better (3.81).

Hypothesis testing

Hypothesis 1 It was hypothesized that the means for philosophical objectives of technology education are equal among the three survey groups.

Conclusion 1 Based on the findings reported in Table 20, the null hypothesis was rejected at the .05 level of significance. The means of the use of tools and machines factor was significantly different among the three subject groups. No other factor (technological literacy, conventional IA objective, and intellectual development) was found to be significantly different among the three groups.

Hypothesis 2 It was hypothesized that the means for problems confronting technology education programs are equal among the three survey groups.

Conclusion 2 It was found that no significant difference existed among the three survey groups on all six problems factors. The null hypothesis was retained at the .05 level of significance.

Hypothesis 3 It was hypothesized that the means for possible solutions to problems confronting technology education programs are equal among the three survey groups.

Conclusion 3 It was found that no significant difference existed among the three survey groups on each of six solution factors. Thus, the null hypothesis was retained at the .05 level of significance.

Hypothesis 4 It was hypothesized that the means for prospects of technology education are equal among the three survey groups.

Conclusion 4 No significant difference of group means was found among the three survey groups on the three prospect factors. The null hypothesis was retained.

Hypothesis 5 It was hypothesized that the selected independent variables do not contribute to the prediction of subjects' perception of the four philosophical objective factors of technology education.

Conclusion 5 Based on the findings reported in Table 24, the null hypothesis was rejected at the .05 level of significance. The results also indicated that no variable was significantly correlated with the one objective factor, use of tools and machines. The independent variable, salary for teaching, was entered into the regression model which accounted for 9.1 percent of the variances for conventional IA objective. For the intellectual development factor, teaching percentage in 1981-82 was included in the regression model and accounted for 8.4 percent of the variances.

Hypothesis 6 It was hypothesized that the selected independent variables do not contribute to the prediction of subjects' perception of the six problem factors of technology education.

Conclusion 6 The results indicated that no independent variable was significantly correlated with teaching content factor. The enrollment trends of the TE program was significantly and negatively correlated with the teacher education program factor. For the student recruitment factor, only enrollment trends of the TE program were entered into the regression model and accounted for 8.2

percent of the variances. The faculty specialty in TE was found to be significantly and negatively correlated with the facility factor. For the teacher shortage factor, three independent variables, enrollment for TE program, salary in industry, and graduates' employment in teaching in 1986-87, were included in the regression model and accounted for 28.4 percent of the variance.

Hypothesis 7 It was hypothesized that the selected independent variables do not contribute to the prediction of subjects' perception of the six solution factors of technology education.

Conclusion 7 Three independent variables were entered into at least one regression model of the solution factors. These variables included (1) technological impact, (2) faculty specialty in TE, and (3) technology adaptation. The null hypothesis was rejected at the .05 significance level.

Hypothesis 8 It was hypothesized that the selected independent variables do not contribute to the prediction of subjects' perception of the three prospect factors of technology education.

Conclusion 8 The results indicated that the curriculum emphasis in 1986-87 was the only variable which entered into each of the three regression models. The enrollment for IT program variable was also appeared in two regression models. The null hypothesis was rejected at the .05 significance level.

Recommendations for Reform

Technology education, like many other fields of study, is going through a period of reform because of changes in its environment. During this effort great attention is being paid to examine the following questions: Should the study of technology form part of public schools' curricula? If yes, what should be the detailed subject matter? Should the study of technology constitute a subject matter worthy of special attention? If yes, what should it be? The discussion of these issues and a proposed technology education model and some suggested directions to technology education profession are presented in this section.

Should the study of technology form part of public schools curricula?

The term "technology" has been defined in many ways by various authors. Defining technology as "tools", "techniques", and "knowledge" has been widely accepted among technologists, scientists, economists, socialists, and educators. Mesthene (1981) defines technology as tools in a general sense, including machines, but also including linguistic and intellectual tools and contemporary analytic and mathematical techniques. He further indicates that technology is the organization of knowledge for practical purposes. Defining technology as knowledge is further advocated by Brooks (1981). He indicates that the defining feature of technology is that it is "public knowledge." But rather than knowledge of how and why things are as they are, it is knowledge of how to fulfill certain human purposes in a specifiable and reproducible way. Another definition given by the National Science Board Commission on Precollege Education in Mathematics, Science and Technology (1983) states that technology consists of the tools, devices, and techniques that have been created to implement ideas born of science and engineering. Technology exists to manage and modify the physical and biological world in a constructive way.

A more comprehensive definition given by Hales and Snyder (1982) states that technology is the knowledge and study of human endeavors in creating and using tools, techniques, resources, and systems to manage the man-made and natural environment for the purpose of extending human potential and the relationship of these to individuals, society, and the civilization. These definitions characterize technology as being: (a) knowledge-based; (b) interdisciplinary involving scientific and mathematical principles; (c) application of knowledge for practical purposes; (d) accumulative; (e) fundamental to humanity; (f) able to maintain a harmonious relationship between human life and nature; and (g) able to develop human potential. These definitions and their subsequent characteristics can be used to serve as the content base from which the teaching content of the study of technology can be derived.

The logical starting point in discussing the role of the study of technology in public secondary schools' curricula is to examine the characteristics of the general education framework and its implication in the modern technological society. General education, as implemented in public secondary schools, attempts to make individuals capable of understanding themselves and the world they live in through the knowledge of spiritual values of the race and the representation of scientific generalizations that contribute to the development of the individual (McGrath, 1947). It is designed to prepare students to be helpful contributing members of society by giving the individuals as much training and learning as they could comprehend, use, and enjoy (Barker, 1947). In other words, the goal of general education is one of producing intelligent, responsible, cultured, and productive human beings.

In reviewing relevant literatures pertaining to general education, Starkweather (1986) states that the values held during the time frame that the general education is acquired become a most important factor in assessing the quality of a person's education. The nature of one's general education should be viewed in relationship to the events occurring in society during the time of that education. The definition of an educated person is embedded in its own time frame. In that sense, the nature of general education has also been altered as technology has changed. Few people will argue that the advancement of technology has not affected the nature of one's life and educational needs. The advancement of technology and the expansion of knowledge created an important need to prepare individuals with a background in elements of all spheres of human learning. This expansion of knowledge along with the development of an increasingly complex industrial society created a need for many varied skills not previously required of the less sophisticated technological environments. Thus, the future general education should exist to aid members of society in keeping abreast of cultural and technological changes of their time.

We are now living in an age of unprecedented technological innovation and domination. The pervasive influence of technology upon our comtemporary situations seems qualitatively different from that of past societies. As indicated by Mesthene (1981) that our tools are more powerful than any before. Dust storms, for example, lay whole regions waste, but too much radioactivity in the atmosphere could make the planet uninhabitable. The domestication of animals and the invention of the wheel literally lifted the burden from man's back, but computers could free him from all need to labor. This quality of finality of modern technology has brought our society, more than any before, to explicit awareness of technology as an important determinant of our lives and institutions. As a result, our society is coming to a deliberate decision to understand and control technology to good social purpose and is therefore devoting significant effort to the search for ways to measure the full range of its efforts rather than only those bearing principally on the economy. It is this prominence of technology in many dimensions of modern life that seems novel in our time and deserving of explicit attention.

Functions required of a citizen to perform in a technological society are given by Maley (1987b); he states that the citizen should be:

1. a user of a vast array of technology;
2. a decision-maker - both personal and as a citizen regarding technology;

3. a purchaser and consumer of a wide variety of technology;
4. a key element in the further use or development of technology; and
5. a worker and wage earner in an increasingly technological work-place.

The concerns for the relevancy of general education in our schools and for re-examination, and perhaps some internal adjustment in keeping with the human needs of people living today, have drawn attention from many educators. The National Science Board Commission on Precollege Education in Mathematics, Science and Technology (1983) identifies understanding of technology as a "basic" in education and a part of the general literacy of all people. In its report entitled "Educating Americans for 21st Century", it states that in a sense, we are speaking of "basics" in education, and we are identifying the knowledge and understanding of technology as basic. Technology literacy is quite different from scientific literacy and mathematical literacy. An understanding of scientific and mathematical concepts doesn't automatically result in an understanding technology.

Lisensky (1985) in his article titled "Technology and the Liberal Arts College," states that the critical task in directing our technological future will be to understand the trade-offs in regard to resources, risks and social values. To this end, liberal arts colleges need to include the "third culture" - the artifact world, and its complex technological system - as an integrated part of their curriculum.

All of these call for a form of technological literacy for all kinds of people that is unparalleled in the history of human-kind. This is not a literacy that is restricted to certain groups or individuals; it is a literacy demanded of all people. It is universal as well as highly individualistic in nature; thus, the issues of the need for technology education become persuasive.

The need for technological literacy for all people in a modern technological society is prevalent and obvious. The questions to ask, then, are that to what extend people understand technology and its implication to our society, and to what extend the technological literacy has been dealt with adequately in our schools.

Unfortunately, technology has been misunderstood and is often treated as a "black box" (Layton, 1977). Pinch (1988) further indicates that much work on technology, whether it be studies of the process of technological innovation, diffusion, or transfer and whether it be carried out by sociologists or economists, has one characteristic in common - it treats technology as a "black box." He suggests that the first lesson to be learnt from the field of sociology of science is that if we do want to open the black box of technology then researchers will inevitably have to learn something about the technology.

The understanding of technology among people are characterized into three views by Mesthene (1981). The first holds that technology is an unalloyed blessing for man and society. Technology is seen as the motor of all progress, as holding the solution to most of our social problems, as helping to liberate the individual from the clutches of a complex and highly organized society, and as the source of permanent prosperity; in short, as the promise of utopia in our time. It tends to be held by many scientists and engineers, by many military leaders and aerospace industrialists, by people who believe that man is fully in command of his tools and his destiny, and by many of the devotees of modern techniques of scientific management.

A second view holds that technology is an unmitigated curse. Technology is said to rob people of their jobs, their privacy, their participation in democratic government, and even, in the end, their dignity as human being. It is seen as autonomous and uncontrollable, as fostering materialistic values and as destructive of religion, as bringing about a technocratic society and bureaucratic state in which the individual is increasingly submerged, and as threatening, ultimately, to poison nature and blow up the world. This view is akin to historical "back-to-nature" attitudes toward the world and is propounded mainly by artists, literary commentators, popular social critics, and existentialistic philosophers.

The third view is of a different sort. It argues that technology as such is not worthy of special notice, because it has been well recognized as a factor in social change at least since the Industrial Revolution, because it is unlikely that the social effects of computers will be nearly so traumatic as the introduction of the factory system in 18th century England, because research has shown that technology has done little to accelerate the rate of economic productivity since the 1880s, because there has been no significant change in recent decades in the time period between invention and widespread adoption of new technology, and because improved communication and higher levels of education make people much more adaptable than heretofore to new ideas and to new social reforms required by technology. While this view is supported by a good deal of empirical evidence, however, it tends to ignore a number of social, cultural, psychological, and political effects of technological change that are less easy to identify with precision. This view tends to be held by historians, for whom continuity is an indispensable methodological assumption, and many economists, who find that their instruments measure some things quite well while those of the other social sciences do not yet measure much of anything.

Each of these views contains a measure of truth and reflects a real aspect of the relationship of technology and society. Yet, they are oversimplications that do not contribute much to understanding. One can find empirical evidence to support each of them without gaining much knowledge about the actual mechanism by which technology leads to social change or significant insight into its implications for the future.

Based on the report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, Maley (1987b) identifies three points as a rationale for learning technology at the precollege level. They are:

1. people must know about technology in order to improve the quality of many personal and professional technology-based decisions;

2. technological literacy prepares individuals for intelligent participation as informed citizens in the transition from an industrialized society to a post-industrialized service and information age; and
3. technological literacy will encourage greater participation by individuals in shaping public policy, which often involves the use of sophisticated technology. It will tend to encourage civic responsibility and overcome voter torpidity, which can arise out of a lack of understanding of new technology.

To cope with the problem of a lack of understanding of technology and its implications in modern society, there is an obvious and pervasive need to design instructional programs that will promote the concept of technological literacy. As to the question, "To what extend has the technological literacy been dealt with adequately in our school?" The answer to this question might be best described by the National Science Foundation's report on the "Science and Engineering Education for the 1980s and Beyond." The report states that the role of science and technology is increasing thoughout our society. Today, people in a wide range of non-scientific and non-engineering occupations and professions much have a greater understanding of technology than at any time in our society. Yet our educational system does not now provide for such understanding (National Science Foundation, 1980). This report explicitly indicates the urgent need for schools to provide technology education to a wide range of people in promoting technological literacy, an increasing necessity in our society. However, our schools have failed so far to meet this need.

What should be the detailed subject matter?

The prime factor in the discussion of what should be taught in providing the understanding of technology and its implications in the modern society may well center around the issue of technological literacy. Technological literacy is such a thrust and it is and will remain vital to all people living in present and future societies. The constituents of technological literacy defines the framework of the curriculum from which teaching content can be derived.

As indicated by Maley (1987b) that technological literacy may take many forms and perspectives depending on who is speaking or writing. International Technology Education Association (1985) defines the technological literacy as an understanding of technology and its dynamics, the opportunities it offers, its impact on products and processes, markets, organizational structures and people. This technological literacy is centered at the understanding of sociotechnical systems which include interrelated social and technical components. According to Kline (1977) the sociotechnical systems are generally goal-directed and typically include the following elements - people, technics, social organizations, ideological bases, resources of materials, available energy, and information. Technology in modern society can be viewed as complex sociotechnical systems that are intimately interwined.

Wright (1981) characterizes the literacy in technology into two levels: technical literacy and technological literacy. Technical literacy includes terms that deal with the technical hardware, processes and practical experience. Technological literacy includes terms that deal with relationships between humans and their technology, including social, cultural and personal experiences. He further indicates that technological literacy is the highest form of literacy and is essential to intelligent functioning within a society.

Numerous studies have investigated what should be included in the study of technology. National Science Board Commission on Precollege Education in Mathematics, Science and Technology (1983) suggests that people must know about technology in order to improve the quality of many personal and professional technology-based decisions. People must understand the limitations as well as the capabilities of emerging technologies. The technologically literate person should have a sense of what technology can and cannot do. He or she should not believe that technology can solve all ills, nor that technology is responsible for most problems. Students must be prepared to understand technological innovation, the productivity of technology, the impact of technology on the quality of life, and the need for critical evaluation of societal matters involving the consequences of technology. Boyer (1983) in his report on "High school: a report on secondary education in American" states that we recommend that all students study technology: the history of man's use of tools, how science and technology have been joined, and the ethical and social issues technology has raised.

Brooks (1981) places emphasis on the importance of management and social supporting systems in a technogical society. He indicates that technology must be sociotechnical rather than technical, and a technology must include the managerial and social supporting systems necessary to apply it on a significant scale. Most highly original inventions such as the Edison electric light, the

Xerox copier, the computer, the Polaroid camera, the automobile, the television system - all involved concepts of complete technological systems that included supporting organizations and markets. He views management as a technology which is important to bring a technical innovation to a successful conclusion. He states that today, managerial innovations are becoming an increasingly important aspect of technology. We see this particularly in the case of computers and communications systems, where not only the software, but also the organization that goes with the system, are inseparable from the physical embodiment of the technology, and are often the most expensive and innovative parts of it. Management, insofar as it can be described by fully specifiable rules, is thus a technology, and indeed every large bureaucratic organization can be considered an embodiment of technology just as much as a piece of machinery. Thus it has been suggested that the greatest innovation in the Apollo program was not the hardware, but the managerial system. This system made possible the degree of reliability and technical discipline necessary to bring the project to a successful conclusion, through the coordination of the activities of hundreds of contractors and subcontractors.

The ability to control the impacts of technology depends, in part, on being able to forecast the likely course of its development. Such impact forecasting, while risky, is essential in the context of efforts to direct technological development so as to gain its benefits while avoiding, to the degree possible, its costs (Teich, 1981). Some forms of technological forecasting focus primarily on the internal dynamics of technological development - extrapolating trends in the characteristics of technologies, searching for correlations among technologies in related areas, looking for impacts of one form of technological development upon other technologies. Others are more concerned with technology-society interactions: with the influence of various technological innovations on social, political, economic, and other institutions, and with the influence of these institutions on the course of technology.

In recent years there has been a growing feeling among those concerned with the social dimensions of technology that it is not enough to assess and control technology, but that what is needed is an overall reshaping of technology. The adherents of this view are less interested in abstract critiques of technology and more concerned with the practical long-term viability of mainstream, industrial technology in the face of limits on investment capital, resource constraints, and the limited capacity of the earth to absorb pollutants. Central to these discussions is the notion of "alternative" or "appropriate" technology (Teich, 1981).

Appropriate technology is a philosophy or way of looking at technology rather than a type of hardware. In a way, it is a set of design criteria as much as anything else - design criteria that stress simplicity, individual worth and self-reliance, labor-intensiveness rather than capital-intensiveness, minimum energy use, consistency with environmental equality, and decentralization rather than centralization. Many of the ideas about appropriate technology originated among people concerned with the failure of modern industrial and agricultural technology to adequately serve the needs of less-developed countries, and a variety of appropriate technology concepts are being put to use in the third world through indigenous efforts as well as development assistance programs. At the same time, the relevance of appropriate technology notions to industrialized nations, especially the United States, is being explored.

It is a difficult task to identify a list of items, that constitute the technological literacy, everyone agrees upon. We may attempt here to try to just do that task although a complete list is not necessarily guaranteed. It is suggested that serious consideration in the curriculum design for the study of technology should be given to the following items which are derived from the research and literature reviewed:

1. knowledge and understanding of the history, evolution, nature, and development of technology;
2. knowledge and understanding of technological systems including tools, machines, materials, techniques, and processes;
3. understanding of the impact of technology on the quality of life;
4. understanding of the capabilities and limitations of technology;
5. evaluation of societal matters involving the consequences of technology;
6. understanding the relationship between science and technology;
7. understanding the relationship between technological decisions and human value;
8. understanding the environmental impact of technology;
9. knowing the relationships between technology and management and its supporting systmes;
10. the ability to assess and forecast effects of technology;

11. understanding of appropriate technology;
12. monitoring of changes occurring in current technology; and
13. understanding of human volition.

Should the study of technology constitute a subject matter?

This section centers on the discussion of following two questions: "Should the study of technology constitute a subject matter worthy of special attention?" If yes, "What should it be?"

A central role of an educational institution is to offer a curriculum that gives its students a basic understanding of the society in which they live and function. Proceeding from this premise, it is logical to assume that in a democratic, technological society, the curriculum would strongly reflect those characteristics (Waetjen, 1985). The challenge then becomes: how can the school help the child learn to gain an understanding of their technological society through means that enable them to meet successfully their developmental tasks at the time the tasks are arising? In facing this challenge, let's first ask the question "to what extent do our schools provide such understanding of technology to our children?" The scenario of study of technology in our schools has been described in a National Science Foundation report on science and engineering education (1980). The report states that the role of science and technology is increasing throughout our society. Today, people in a wide range of non-scientific and non-engineering occupations and professions must have a greater understanding of technology than at any time in our society. Yet our educational system does not now provide for such understanding. Boyer (1983) also comments that we are quite frankly disappointed that none of schools we visited required a study of technology. More disturbing still is the current inclination to equate technology with computers.

The schools fail to fulfill their role in providing technology education, in part, because that technological literacy is interdisciplinary in nature and emcompasses industrial arts, science, mathematics, and social (humanity) studies disciplines. No one individual discipline is able to solely fulfill this responsiblitity. To cope with this curriculum deficiency in the study of technology, Boyer (1983) proposes a one-semester technology course in which one technological advance - the telephone, the automobile, television, or the minicomputer, for example - might be chosen to trace its development, and examine the positive and negative impacts it has on our lives today.

The next question that needs to be asked is "can the goal of achieving technological literacy be fulfilled through the innovation of an existing subject such as science, mathematics, social (humanity) studies, or industrial arts in our current school curricula?" Beginning with science and mathematics we quote report by the National Science Board Commission on Precollege in Mathematics, Science and Technology (1983) which clearly delineates the differences between mathematics, science and technology. It states that technology literacy is quite different from scientific literacy and mathematic literacy. An understanding of scientific and mathematical concepts does not automatically result in an understanding of technology. Similarly, Gies (1982) in his discussion of "Technology: A New Liberal Art," states that technology is not to be confused with science. Science is what the universe, macrocosm and microcosm, consists of - stars, planets, galaxies, cells, atoms, particles. Technology is tools, machines, power, instrumentation, processes, techniques. These statements clearly differentiate the science and mathematics from the technology. In that sense, it is acceptable to say that the science and mathematics subjects are not adequate in providing technological literacy required of citizenry in the modern technological society. Yet both are essential to comprehending technology.

As to social sciences (humanity) subjects, no evidence in the literature reviewed shows that these subjects alone can significantly contribute to the goal of achieving technological literacy in citizenry. In truth, technology has an unique impact on society. The study of technology and social sciences (humanity) subjects have much to contribute to each other. Using social sciences (humanity) subjects to explain effects of technological advancement on our modern life can help students understand technology better, and vice versa.

To explain the role of industrial arts in providing technological literacy, Bender (1982) states that it is not the responsibility of the industrial arts profession to solely fulfill the school's role in providing technology education. Other school subjects have been challenged to do the same. However, due to the nature of our subject matter, we have an advantage and a responsibility to contribute toward the fulfillment of this task. The traditional industrial arts programs are already interrelated to the study of technology in that they provide students with knowledge concerning the use of tools and materials and techniques. His view is commonly shared by other practitioners in industrial arts profession. They proposed a name change for the subject of industrial arts from "industrial arts" to "technology education", a discipline devoted to promote technological literacy. This name change proposal has been approved and widely adopted by the industrial arts practitioners. Many efforts have also been made to expand content of technology education subject to include the macro aspect of technology as contrasted with the traditional micro approach.

Advocates of technology education define technology education as the comprehensive curriculum area which has an action based instructional program concerned the evolution, utilization, and significance of technology; the organization, personnel, systems, techniques, resources, and products of industry; and their combined social and cultural impacts (International Technology Education Association, 1985). This definition communicates explicitly that technology and industry are two main sources from which the content of technology education is derived.

The newly innovated technology education subject, comtemporary industrial arts, seems capable of fulfilling the goal of achieving technology literacy through a sound curriculum design and activity selection.

A proposed technology education curriculum

As a subject of study in the public schools technology education is going through a period of change. The attention of this effort centers around the content of technology education as the description of what knowledge is to be taught. The traditional industrial arts, precursor of technology education, is based in the curriculum content model of wood, metal, and drawing while the contemporary technology education curriculum content is based on socio-technical frameworks in which to examine technology and industry. The genesis of using technology as the content base of the subject dated back to 1947. At that year Warner introduced "A Curriculum to Reflect Technology" at the 1947 American Industrial Arts Association Conference. Warner and his associates (Warner, Joseph, Carlton, Gerbracht, Lisack, Kleintjes, and Phillips, 1965) reasoned that there was a more dynamic way of conceptualizing industrial arts content and that knowledge should be the content base of the subject. Since the introduction of "A Curriculum to Reflect Technology", industrial arts education researchers, teacher educators, and practitioners have been working to identify and change the educational paradigm of the field. Significant contributions have been made by Maley in instructional methods, Towers, Lux, and Ray in a rationale aimed at the academic rationalist orientation and content identification, and by DeVore in content identification through a humanistic curriculum orientation (Zuga, 1985).

One recent effort in defining curriculum base for comtemporary technology education is the Jackson's Mill Industrial Arts Curriculum project. It is the endeavor of 21 industrial arts educators who tried to define a common curriculum model to more accurately reflect technology and represent a real discipline of study. Four distinct yet interrelated and interdependent industrial/technological systems, communication, construction, manufacturing, and transportation, are identified as the content of technology education subject in the Jackson's Mill curriculum project. This curriculum project has been widely accepted by the practioners in the field, however, it falls short of including such major technologies as computers, microelectronics, and energy processes and utilization. A modification of the curriculum model for a more inclusive representation of the technology is necessary. Thus, it is the purpose of this attempt to present a curriculum model for teaching technology education K-12.

Curriculum framework   In contrast to once separate, discrete crafts, trades, or enterprises with one-dimensional relationship, as organized in traditional industrial arts curriculum, a new way of perceiving technology is to view technology as a total system composed of many elements and subsystems, each critical to the functioning of the whole with multimensional relationships. It is this new perspective of perceiving technology and technical development to form the fundamental base for the content derivation for contemporary technology education. Emerging from this new perspective, are four distinct yet interrelated and interdependent technology/industrial systems: construction, energy utilization, information, and manufacturing. Note that these four technical systems in the Jackson's Mill project are communication, construction, manufacturing, and transportation. Each system has a central theme, is universal in all societies, has unique questions and problems, and contributes in some way to the survival of human beings (Hales and Snyder, 1982).

Directly adopted from the Jackson's Mill Industrial Arts Curriculum project, a knowledge-adaptive system interaction model as shown in Figure 1 describes how human adaptive systems mutually interact with the domains of knowledge and contribute to one another. As people discover more knowledge, it helps them adapt. As people develop better and improved way of adapting, they contribute to the domain of knowledge. Four domains of knowledge have been identified; sciences, humanities, technologies, and formal knowledge. The first three domains are intrinsically linked. The fourth domain, formal knowledge - represented

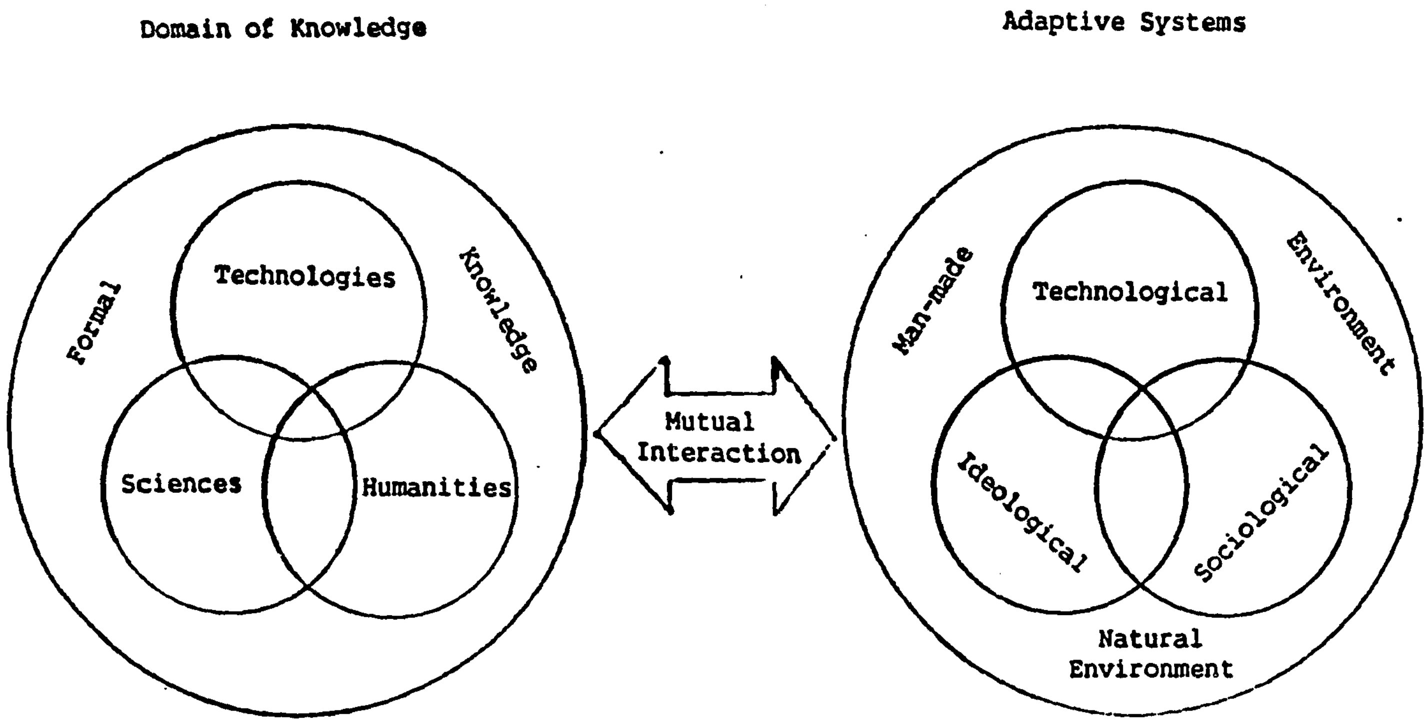

Figure 1. A knowledge - adaptive system model

by language, linguistics, mathematics, and logic - is a separate, distinct domain, providing form and structure to the other three domains.

The evolution of human beings and their social and technical orders can be understood by analyzing three human adaptive systmes: the technological, sociological, and ideological. Ideological systems address values, beliefs, assessment, problems, issues, impacts, new knowledge structures, and perceptions of reality as well as new or future social directions. Sociological systems focus on institutions, including family, religion, government, education, and the economy. Technological systems pertain to technical means of manipulating the physical world to meet basic needs of survival - food, clothing, shelter - as well as providing other goods, services, and means for extending human potential. These three adaptive systems are interrelated and exist within the man-made and natural environments.

The study of technology with the goal of achieving technological literacy may be accomplished if a reasonably accurate and well-defined model is derived from which curricular and programmatic decisions can be made. The content for technology education should be drawn from the knowledge of the three systems of human adaptive behavior and human technical endeavors that exist to expand human potential. Figure 2 shows a technology education curriculum model which indicates how the four subsystems of human technical endeavor are related to the sociocultural/physical environments. The subsystems of the human technical endeavor are construction, energy utilization, information, and manufacturing. Each of these subsystems represents a discrete human endeavor that can be studied in isolation. They must also be viewed as they are interrelated to one another. Each is continually influenced by the natural and sociocultural environments.

The construction system Construction is a technical adaptive system designed by people to use resources efficiently to build structures or to constructed works on a site. The production of constructed goods must be skillfully managed. This implies that each step involves planning to perform the task, organizing to build the structure, directing to ensure efficient construction practices, and controlling to get the best results. The system produces residential, commercial, industrial, and heavy/highway structures on a site, often one of a kind (Hales and Snyder, 1982). Figure 3 shows a construction curriculum development model. The four major subdivisions of the model are resources, technical processes, management,

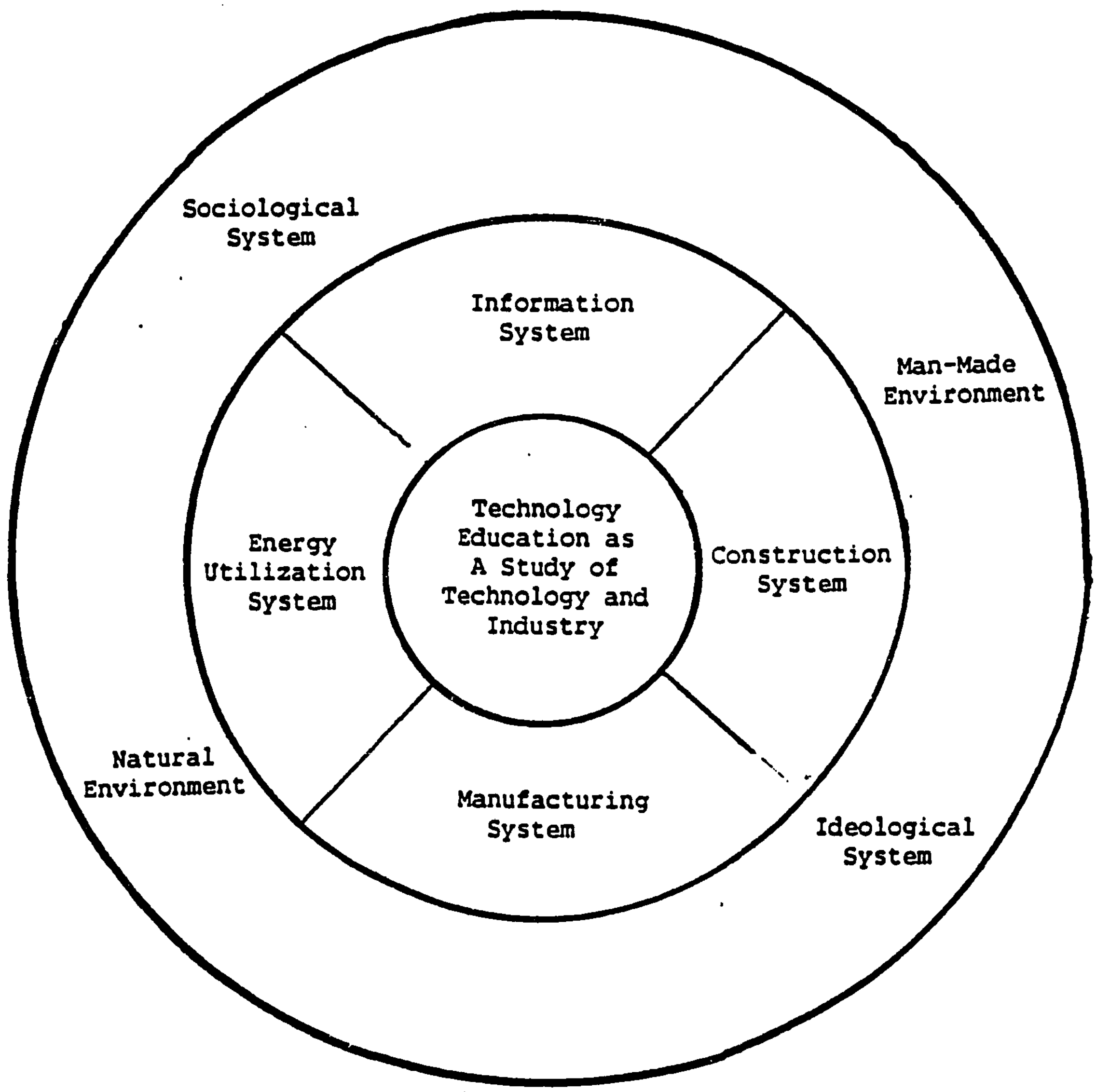

Figure 2. Technology education curriculum model

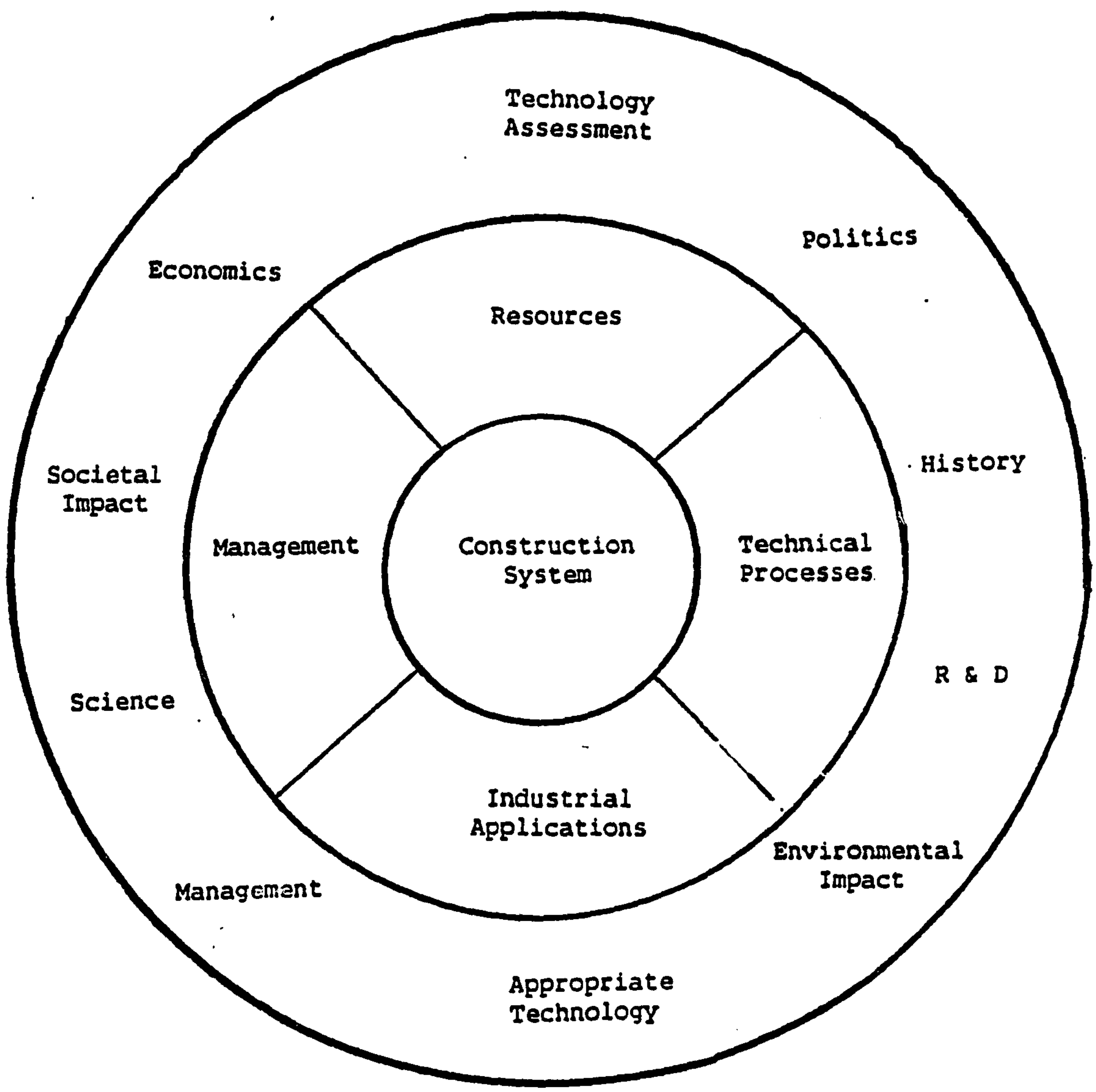

Figure 3. Construction system curriculum development model

and industrial applications. Each of these major divisions are further divided as follows:

Resources consist of personnel, tools, materials, capital, and energy.

Technical processes include preparing the site, setting up temporary facilities, surveying for construction, earthworking, setting foundations, building the major structural elements, installing circulatory systems, completing the structure, and completing the site.

Management is organized into four groups of activities, initiating the project (project programming, appraising, estimating, funding, and budgeting), developing the project (designing, and engineering), implementing (contracting, scheduling, procuring, and supervising), and staffing (hiring, training, working, advancing, retiring).

Industrial applications are classified into two categories, structures (residential, commercial, and heavy/highway), and services (installation, maintenance, and repair).

As indicated in the model, a technological system is interacted with ideological and sociological systems within the man-made and natural environments. The impact of technological advance on the society and environment should be emphasized in the curriculum. These topics such as enterprise management, technology assessment, appropriate technology, and research and development should be the main content in the senior high programs.

The energy utilization system   Energy utilization is a technical adaptive system designed by people to use energy resources efficiently to obtain power conversion and control, and to transport materials/goods and people. Figure 4 shows an energy utilization curriculum model. The four major divisions of this curriculum development model are resources, technical processes, transportation, and industrial applications. Each of these major divisions are further divided as follows:

Resources are organized into the four forms of energy: nuclear, chemical, mechanical, and heat/light (Mueller, 1981).

Technical processes are divided into conversion, control, transmission, and storage.

Transportation includes material handling, packaging, loading, transporting and receiving.

Industrial applications consist of warming/cooling,

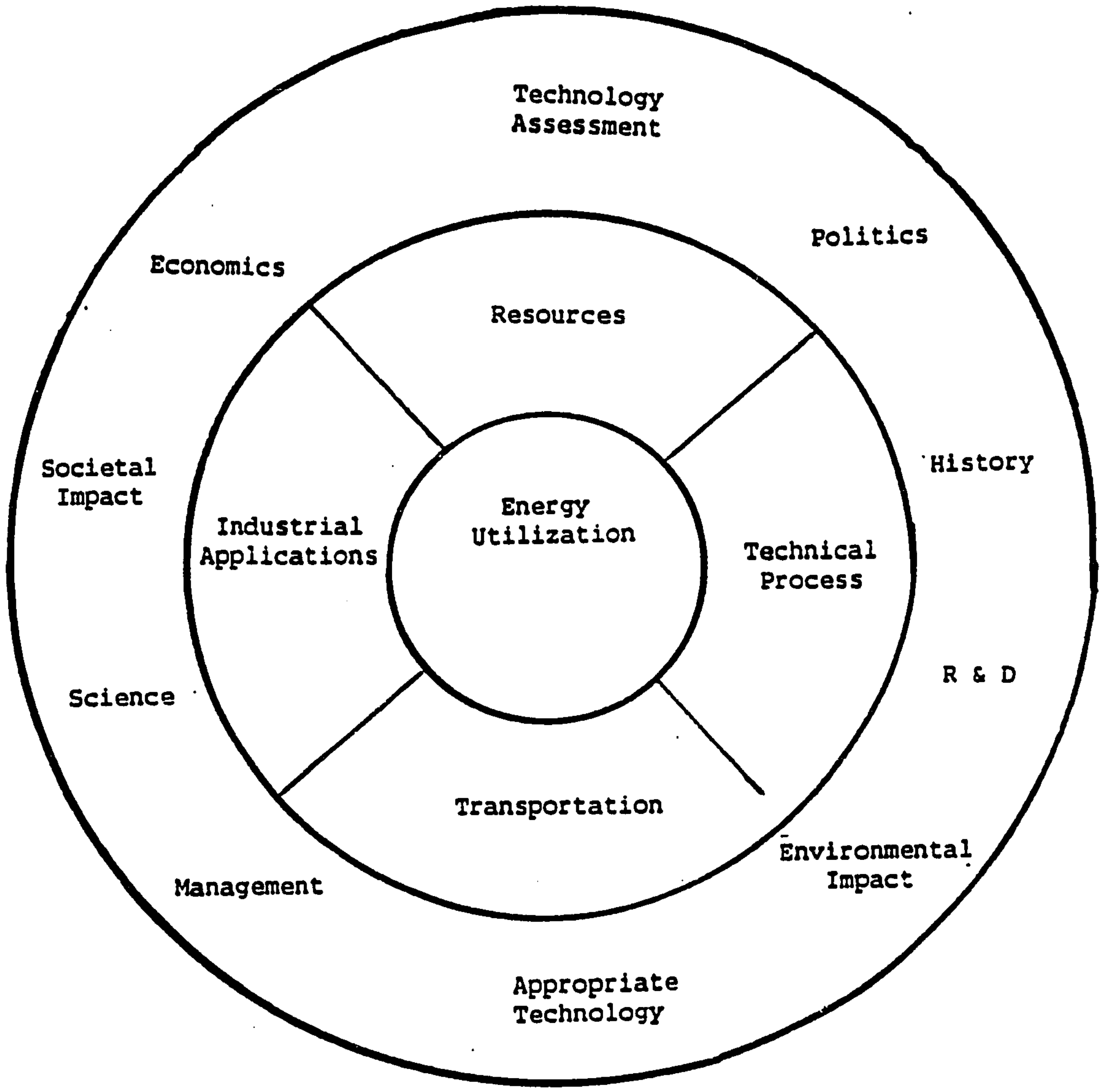

Figure 4. Energy utilization system curriculum development model

lighting, and propelling (Mueller, 1981).

Figure 5 gives a more detailed subdivision of the resource section of the energy utilization model. As can be seen that nuclear is divided into short life and long life isotopes. Chemical is further divided into the sources of coal, oil, wood, natural gas and reactive chemicals. Mechanical energy can be subdivided into wind, water, and animal. The two divisions of heat/light are solar and geothermal.

The four subdivisions of technical processes can be further refined. Energy conversion can be grouped into direct and indirect methods. As shown in Figure 6, the direct and indirect methods describe conversion techniques from one form of energy to another. It can be, for example, from solar to electricity, from wood to heat, and from light to electricity. Control of energy can be achieved by three means, electrical, mechanical, and fluid power (hydraulics and pneumatics). Transmission of energy is achieved through the media of electricity, fluid, heat, light and mechanical. Energy may be stored in forms of chemical, capacitive, thermal or mechanical.

There are five organizers for transportation including material handling, packaging, loading, tranaporting, and receiving. Figure 7 shows the three organizers for

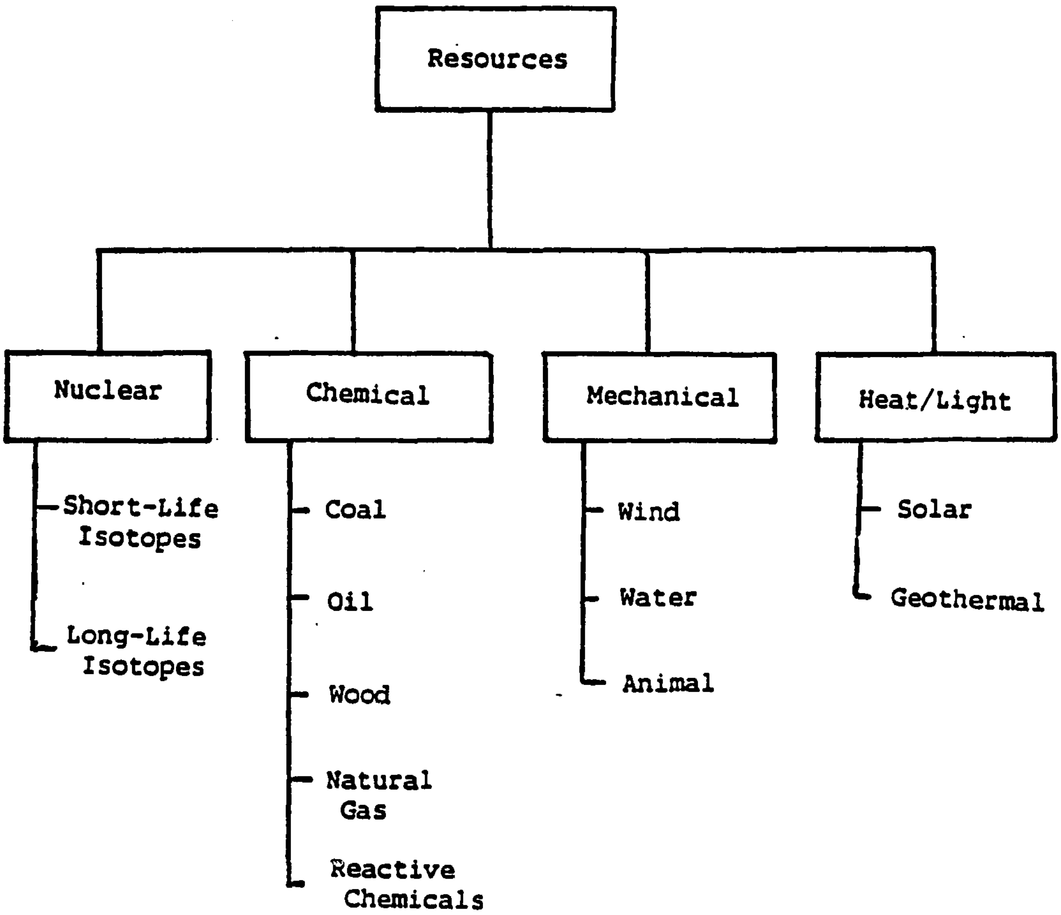

Figure 5. Energy resources chart

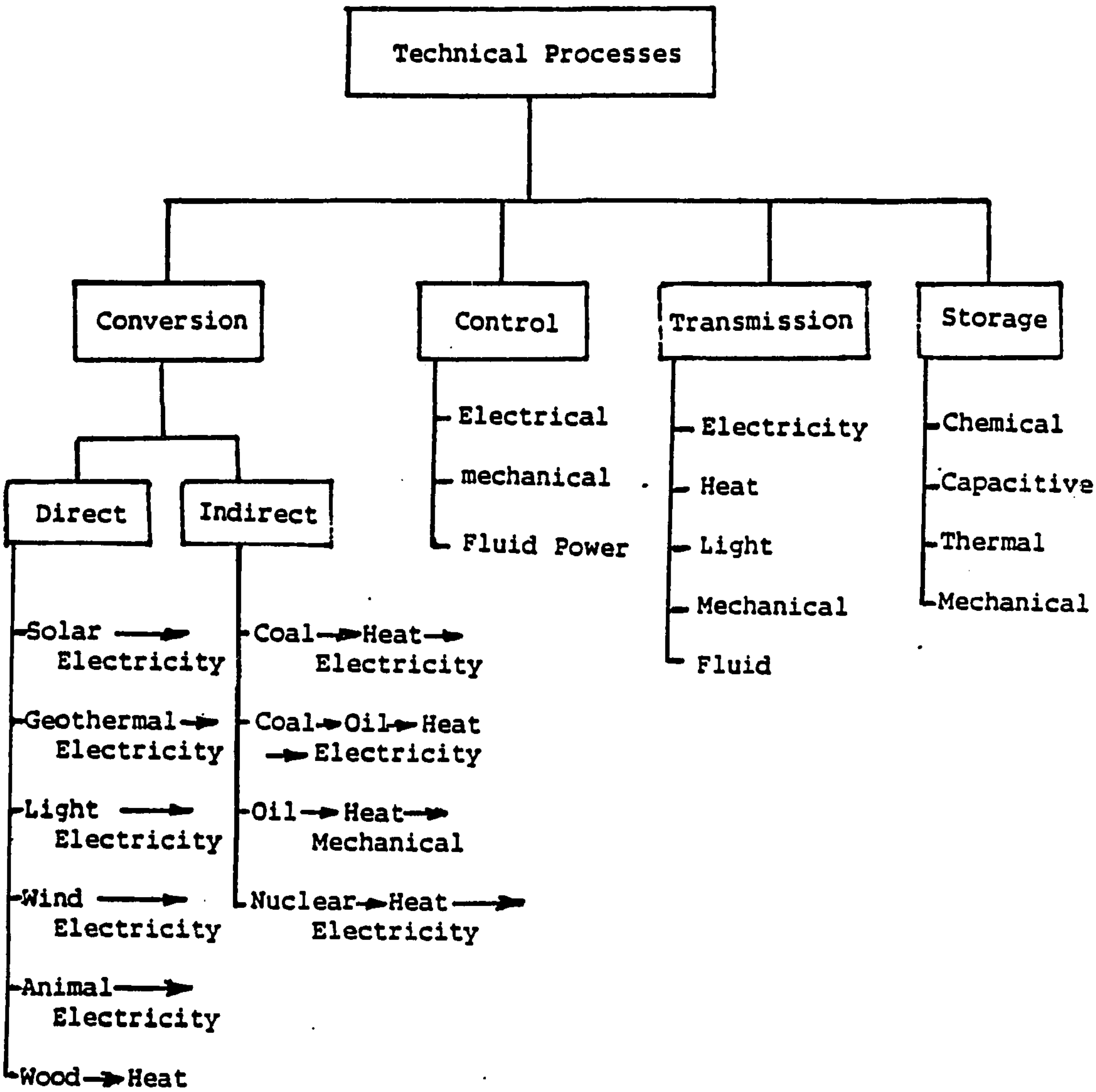

Figure 6. Energy technical processes chart

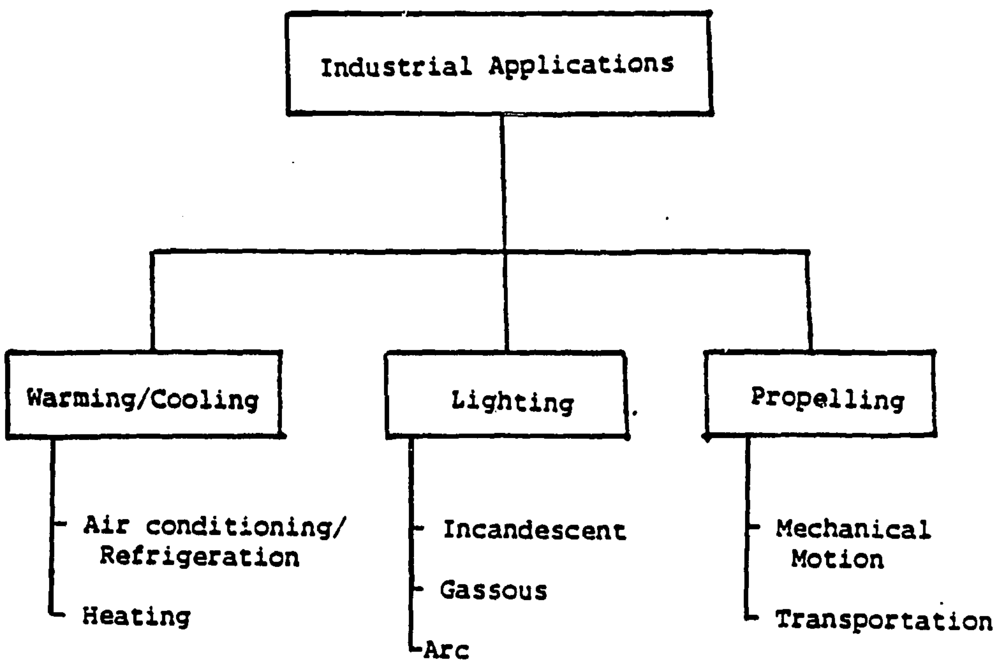

Figure 7. Energy applications chart

industrial application of energy. They include warming/cooling which may be further divided into air-conditioning/refrigeration and heating. The three forms of lighting are incandescent, gaseous, and arc. The applications of propelling are in the field of mechanical motion, linear or rotary.

The information system   Information is a technical adaptive system designed by people to transfer, deliver, and receive information to extend human potential. The extension is made so that the human senses can function beyond their natural state. Figure 8 illustrates an information curriculum model. It consists of six major divisions: drafting, graphic arts, broadcasting, computers, telecommunication, and microelectronics. The intercorrelated relationships between these technologies and ideological and sociocultural systems are also indicated in the model.

The heart of an information system is controlled by a network of information processing know as the information (or communication) process. A simple model of the information process is illustrated in Figure 9. It shows the process that information must be conceived and then converted into messages through encoding, transmitting, receiving, and decoding processes before it reaches the

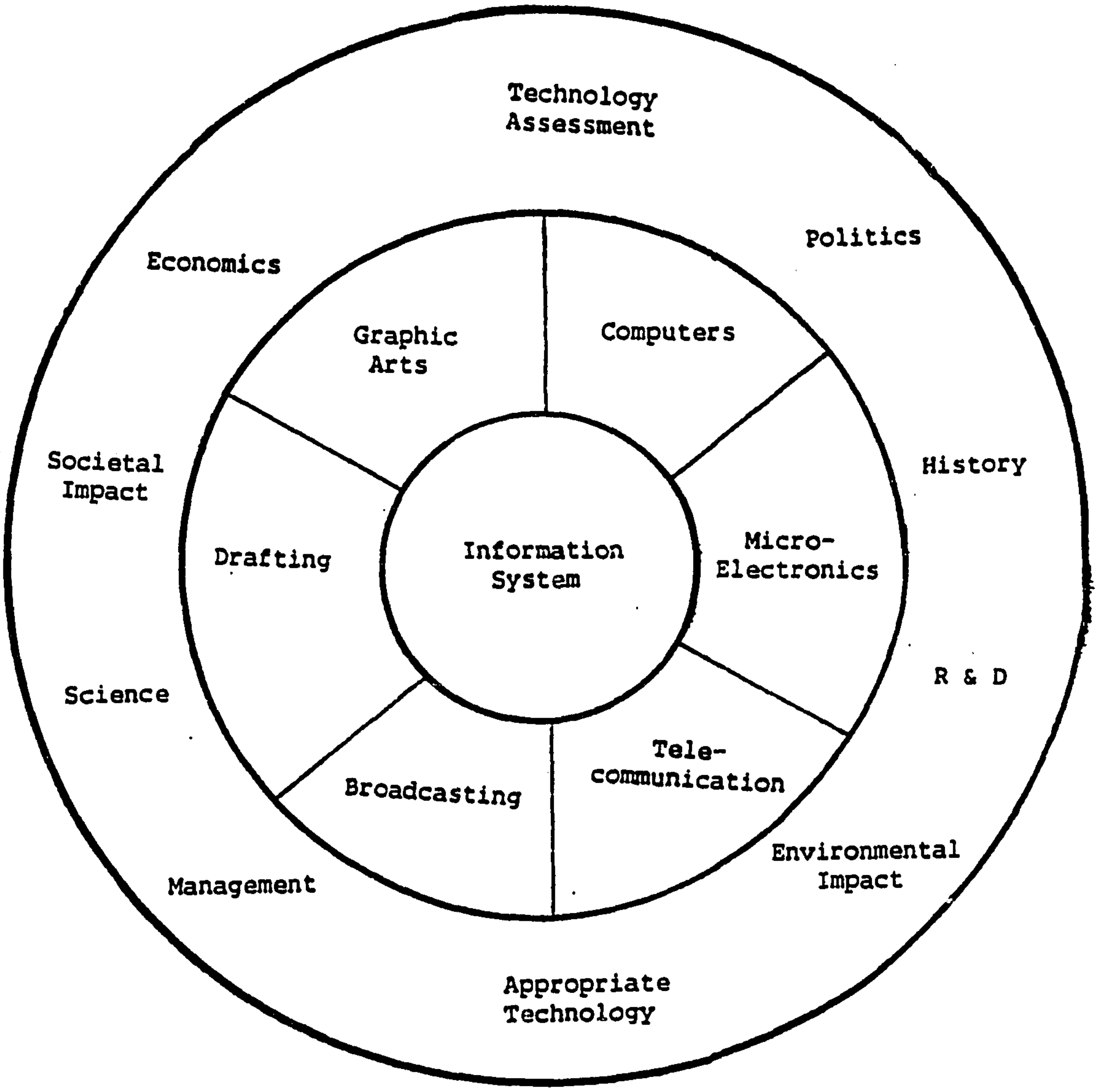

Figure 8. Information system curriculum development model

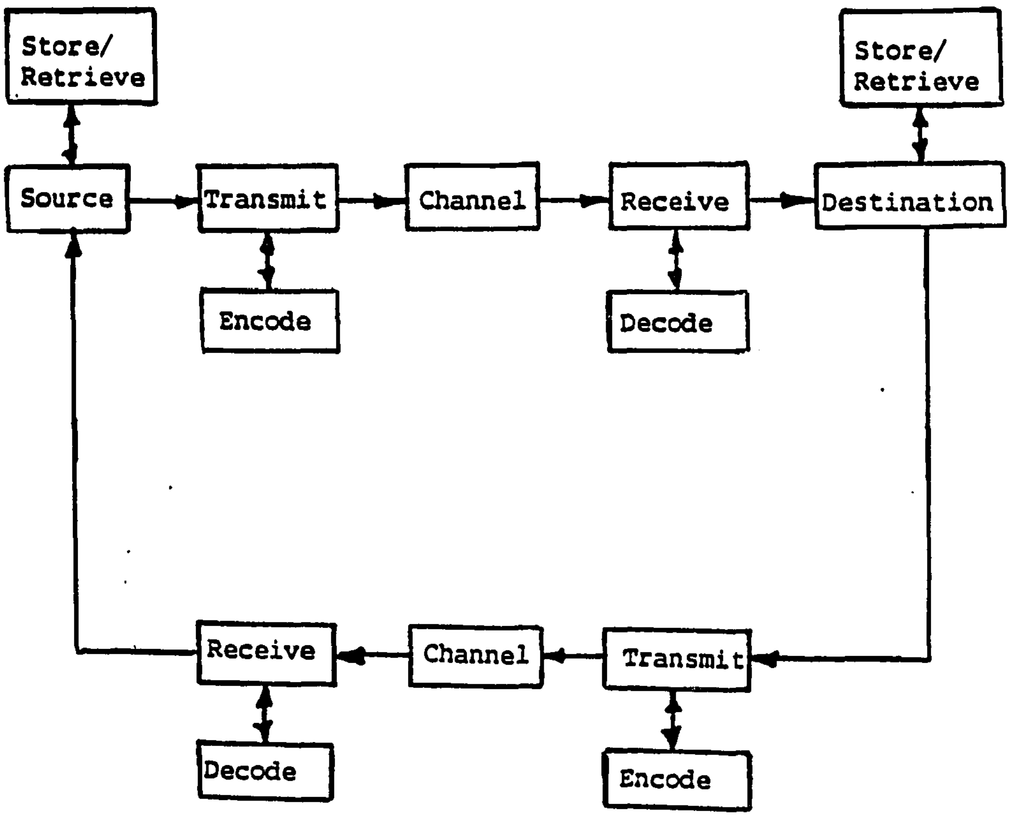

Figure 9. Information process model

destination. The terms identified in the Figure 9 are defined as follows (Ritz, 1981):

Source is the system (human, machine, etc.) desiring to transmit a message (information).

Encoder is the technical means used to put the message into a code form so it may be transmitted with the use of the transmitter.

Transmitter is the technical means (machine) used to transform the information into the channels.

Channel is the pathway (wires, waves, fluids, paper, gears, etc.) that the message travels through from the source to the destination.

Decoder is the technical means used to put the message back into a usable form.

Receiver is an apparatus or device that composes incoming decoded information for use by the destination.

Destination is the system to whom the message (information) was directed.

Storage/Retriever component is an element in the process where information can be placed until needed.

<u>The manufacturing system</u> Manufacturing is a technical adaptive system designed by people to use resources efficiently to formulate ideals, to design and analyze functionality and material properties, to plan processing procedures, to process materials, to evaluate the products, and then assemble into industrial and consumer goods. Figure 10 shows a manufacturing system curriculum model. The five major divisions of this curriculum development model include design and analysis, management, materials, process methods, and evaluation.

In the design and analysis phase, the ideas are converted into detailed design drawings. Enginnering functionalities, stress/strain, cost, and reliablity analyses should be included to ensure the appropriateness of the design before the detailed drawings are defined. The detailed process procedures also need to be included in this phase. The use of computer-aided design (CAD), computer-aided manufacturing (CAM), and stress/strain analysis techniques are included and allow students to use the latest computer technologies in technology programs.

The management phase consists of inventory, personnel, marketing, and servicing. Five types of materials commonly used in manufacturing are woods, metals, ceramics, plastics, and composites.

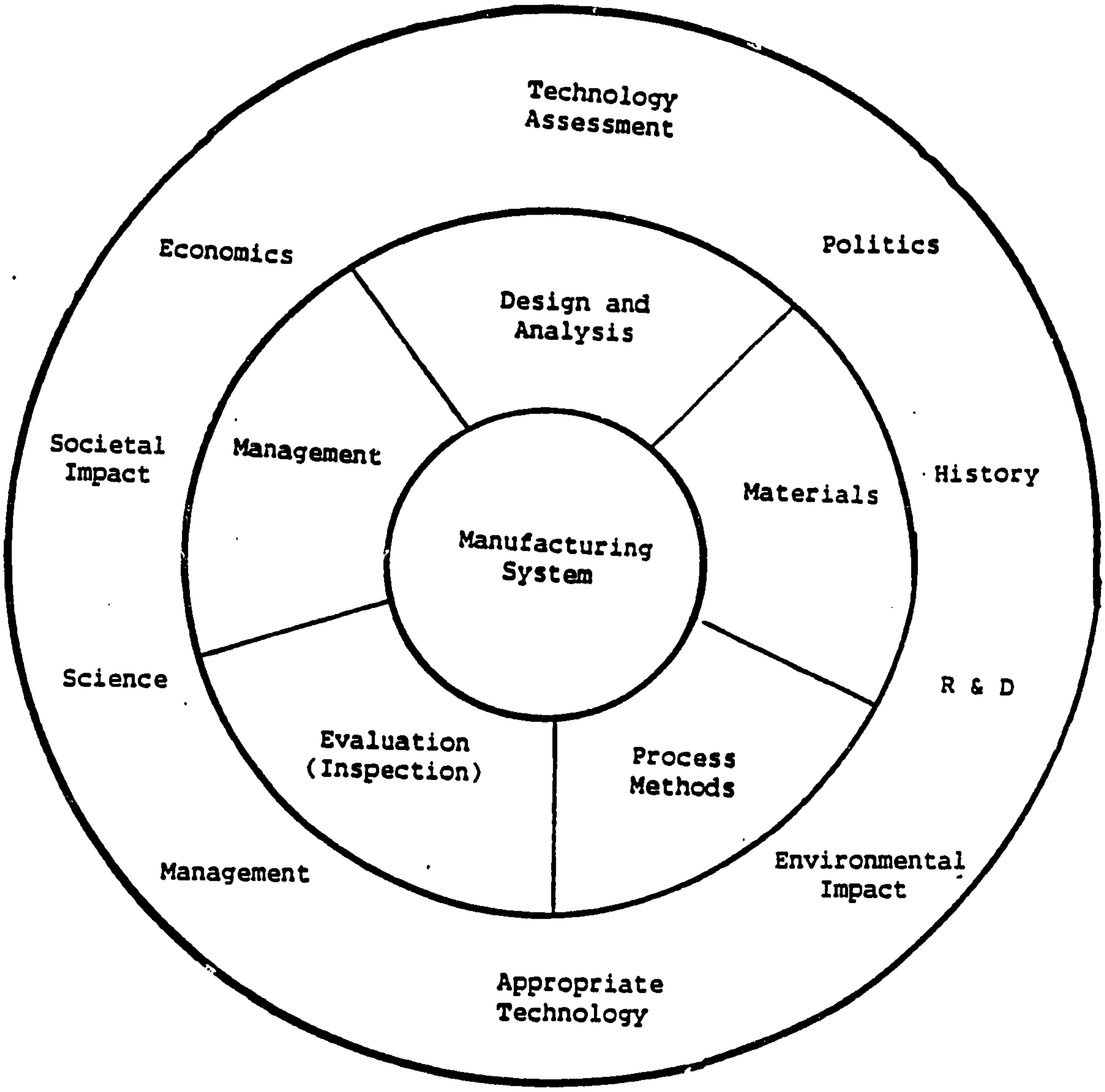

Figure 10. Manufacturing system curriculum development model

Wright and Jensen (1976) classify the material process methods into the following seven areas:

Casting, the process whereby the desired material is prepared in the form of a liquid and then introduced into a previously prepared cavity of proper design. The material is solidified in the cavity before being used.

Molding, the process of changing the size and/or shape of a material by forcing a pliable, semi-solid, and/or powdered material into a prepared cavity.

Forming, the process of changing the size and/or shape, but not the material volume, of a material by the application of a force between the yield point and the fracture point.

Separating, the process of removing material from a base material for the purpose of changing the size, shape, and/or surface finish of the base material.

Conditioning, the process of changing the mechanical and/or physical properties of a material usually by the application of heat, mechanical stress, and/or chemical or electro-magnetic action.

Assembly, the process of semi-permanently and/or permanently fastening two or more materials and/or parts together.

Finishing, the process of treating a base material for the purpose of protecting and/or beautifying that base material.

In evaluation phase, materials and/or finished products are inspected to ensure their good quality. Evaluation methods include material testings, quality control, and statistical process control (SPC).

<u>Scope and sequence (K-12)</u>

Table 28 proposes a scope and sequence model for technology education (K-12). The model is based on the premise that learning is cumulative. It consists of four levels, technology awareness (K - grade 6), technology exploration (grades 7 and 8), technological systems (grades 9 and 10), and advanced technological systems (grades 11 and 12). The model lists objectives for each division of the school and identifies some potential contents in each division.

In awareness level (K-6), the student is introduced to the technology in its broad sense. History of technology, use of technology in the home, business, and industry, and occupations in technological worlds are main components of

Table 28. Scope and sequence model for technology education (K-12)

Instruction Level	Objective and Content
Technology awareness (K - grade 6)	Objective: 1. To develop an awareness and appreciation for the role that technology plays in our lives. 2. To develop an awareness of careers in the advanced technological society. 3. To introduce basic tools (e.g., handtools, computers). 4. To introduce basic materials (e.g., paper, woods, metals, plastic). Content: 1. History of technology. 2. Study of the uses of technology and its use in the home, business, and industry. 3. Use of basic tools (handtools and computers). 4. Use of materials (papers, woods, metals, and plastics). 5. Careers in technological worlds.
Technology Exploration (Grades 7 - 8)	Objective: 1. To gain understanding of each technological systems, construction, energy utilization, information, and manufacturing. 2. To provide opportunities to identify aptitudes, abilities, and interest meaningful to tentative career selection.

Table 28. (continued.)

Instruction Level	Objective and Content
	3. To develop basic skills in the use of common tools. 4. To develop safe working practices. 5. To develop an understanding of the nature and characteristics of technology. 6. To examine and establish beliefs and values based upon the impact of technology and how it alters environments.
	Content: 1. Introduction to construction. 2. Introduction to energy utilization. 3. Introduction to information. 4. Introduction to manufacturing. 5. Sociotechnical systems - technical and social-cultural elements. 6. Use of common tools and processes. 7. Career information.
Technological Systems (Grades 9 - 10)	Objective: 1. To study any one of the technological systems in depth. 2. To pursue advanced technical knowledge in one or more selected systems.

Table 28. (continued.)

Instruction Level	Objective and Content
	3. To discover and develop creative technical talents.
	4. To develop an understanding of managerial and managing skills in an enterprise.
	Content:
	1. Advanced technical processes in a selected technological system.
	2. Enterprise organization and management.
Technological Studies	Objective:
(Grades 11 - 12)	1. To develop problem-solving and decision-making skills.
	2. To develop an understanding of technology assessment.
	3. To develop an awareness of appropriate technology.
	4. To further develop an understanding of the nature and characteristics of technology.
	5. To further establish beliefs and values based upon the impact of technology and how it alters environments.
	Content:
	1. Research and development.
	2. Analysis and evaluation.
	3. Technology assessment.
	4. Appropriate technology.
	5. Case study.

the curriculum. Concrete hand-on activities should be emphasized in this stage. Basic hand tools and computers are the main equipments in the laboratory.

In exploration level (grades 7 and 8), students study each of the four technological systems separately. Depending on the school's scheduling system, each technological system may be taught in one-half or one full semester. The courses are organized in a comprehensive manner to allow students exploring their aptitudes, abilities and interests which may be helpful to their career selection. At this stage, sociotechnical systems are also introduced to investigate how technology affects our society. Development of safe working practice should be emphasized.

In grades 9 and 10, technological systems level, students study any one or more of the technological systems in considerable depth. Advanced technical processes constitute the main course contents. Group projects may be used to introduce the concept of enterprise organization and management.

In grades 11 and 12, technological studies level, students are ready to encounter skills required for the application of the technical means. The students should be able to formulate ideas, to develop procedures, to analyze engineering functions, and to implement the project. Revisiting intercorrelated relationships among the technological, ideological, and sociological relationships after studying technology assessment and appropriate technology should give students a more in-depth understanding of technology and its impact on society. It is noted that the learning and cumulation of knowledge is not complete at grade twelve but goes on for a lifetime.

Directions for Technology Education Programs

As the profession shifts its new emphasis on technological literacy, it creates a new arena and opportunity for the field to grow. However, it also imposes a new challenge and problem that the practitioners in the field have to face. The problems of technology education programs in the secondary schools have been presented in Chapter II. In this section, some feasible directions for solving these problems and meeting the need of new challenges are summarized from the research and a review of literature.

The feasible strategies and directions for solving the problems which are currently confronting the technology education movement have been proposed by many who are in or out of the profession. Worthington (1982) proposed the following measures to deal with the teacher shortage problem:

1. recruit retired teachers to teach part-time;

2. recruit more women into the field;

3. work with business and industry to develop new types of cooperative sharing programs;

4. recruit teachers experienced in other fields whose future careers might be jeopardized because of an over-supply;

5. stress the further development of the American Industrial Arts Student Association which could prove to be a valuable source of both teachers and future leaders;

6. develop a comprehensive public information campaign involving all agencies, associations, and media, which would be geared toward the general public as well as to secondary students and teachers; and

7. work with those agencies of industry who are responsible for finding employment for employees who have been caught in the current economic downturn for possible industrial arts teachers.

Sharpe and Householder (1984) identified nine sources of information which may have influenced respondents to decide to prepare for industrial arts teaching. The ranked means of these sources were: (1) visited university facilities; (2) talked to or corresponded with university personnel; (3) read pamphlets, brochures or other recruitment material; (4) talked with membership in industrial arts or other clubs; (5) heard a university student talking to an industrial arts class; (6) heard a university faculty member talking to an industrial arts class; (7) read a related article in a local newspaper and other material sources; (8) saw slide/film presentation; and (9) watched TV broadcasts. They also found that industrial arts teachers and parents ranked very highly as persons influential in the recruitment process. They further provided nine recommendations for those involved in the recruitment and retention of potential industrial arts teachers:

1. recruitment efforts should be aimed at all age levels of persons, ranging from those in secondary schools to adults;

2. industrial arts teachers, parents, and university faculty members are primary recruiting agents;

3. continue efforts to recruit persons belonging to minority groups into industrial arts;

4. employ a wide variety of recruitment techniques since different sub-groups of the population show a preference for, and selective reactions to, specific techniques;

5. sources of recruitment information should be available and publicized as being available in schools and colleges;

6. visits to university facilities by potential industrial arts education students should be given a major emphasis in the recruitment process;

7. industrial arts teachers in secondary schools should be encouraged to allow their students opportunities to assist other students within the industrial arts laboratory setting;

8. recruitment efforts should involve the school guidance counselor; and

9. relay information relating to realistic conditions in teaching to potential industrial arts teacher education students, and to those students presently preparing to be teachers.

Edmunds (1980) conducted a study on the recruitment techniques used by the industrial arts teacher education programs and their effectiveness. His results indicated that the IA teacher educators are in almost total disagreement, with one notable exception, to recruitment methodology usage and effectiveness. The one point of agreement is the technique of contacting industrial arts teachers, especially alumni. This is the most used method and is rated at the top in effectiveness.

Worthington (1982) criticized the quality of current existing IA/TE teacher education institutions. The curricula at the teacher education institutions simply do not reflect the technology of today. He suggested four directions to deal with this problem: (1) need a "standard" project for the teacher education programs, (2) update the knowledge and skills of the older experienced teacher, (3) offer stronger in-service training programs which are indicative of the technologies of today, and (4) convert existing research and development products into formats or instruments more easily used by the teachers.

Schoonmaker (1984) identified the following seven feasible means for preventing enrollment losses of IA/TE courses in the secondary schools: (1) improve image among secondary school students, (2) highlight and promote more technical, scientific, and problem-solving aspects of courses (3) recruit female students, (4) offer more single-period classes or alter the time of day in which particular classes are offered, (5) improve the ambiance of their facilities such as ventilation and brightness, (6) draw upon the support of parents, teachers, counselors, and other adult figures who might influence student opinion, and (7) recruit student leaders, scholars, athletes, and other students.

The transition of industrial arts to technology education requires a sound overall strategy for promoting the movement. Starkweather (1986) listed the following ten directions for that purpose:

1. develop and improve model technology education programs,

2. expand support for people to develop a technological literacy,

3. upgrade teacher education,

4. research and develop new/improved instructional delivery systems,

5. expand curriculum resources,

6. enhance the expertise of personnel,

7. improve public awareness and support,

8. involve business and industry,

9. increase personal commitment to the profession, and

10. strengthen the foundation for technology education.

The technology education movement brings new challenges to the profession. Some of the challenges observed by Maley (1987a) include:

1. a need to define technology education in a consistent, concise manner that can be understood by the total profession in and out of the International Technology Education Association, as well as the public it is to serve;

2. a need to redefine the content, programs, and practices so that they reflect the concept of technology education;

3. a need to establish relationships with the community beyond the school where understanding and support must be achieved;

4. a need to develop relationships within the school itself aimed at a broader involvement of the other disciplines in a holistic approach to education and understanding;

5. a need to develop a breed of professionalism that will bring about commitment to personal and technical upgrading by teachers and administrators;

6. a need to develop imaginative concepts of laboratory planning and equipment selection for technology education to facilitate implementation of the new content and methodologies;

7. a need to provide for optimum use of existing facilities in locales where economic conditions do not permit major overhaul of laboratories or equipment;

8. a need for the profession to move away from a craft dominated program to one that centers on technology education and is attractive to all students;

9. a need to develop a form of technology education that will have a strong experiential base wherein the theory and practice--the abstract and the concrete--come together to provide increased understanding as well as a meaningful involvement with technology; and

10. a need to develop a form of technology education appropriate for the whole school population to prepare all young people for effective participation in a technological society in our democratic country.

To cope with inadequate financial resources, Worthington (1982) suggested several alternatives that may help alleviate the financial burden being placed on industrial arts/technology education programs. Some of these alternative are:

1. seek financial support, personnel, equipment, and expertise from the private sector;

2. adopt joint-use-of-resources approach with disciplines such as industry, science and engineering education, and vocational-technical education; and

3. use voluntary teachers, including retired IA teachers.

To facilitate the use of existing equipment and facilities in IA laboratories for new technology education courses, Maley (1987a) provided the following suggestions: (1) use computers as a common tool to solve problems, control equipment and communicate, (2) modify the existing unit-shop to teach a technology based general lab. (3) orient the TE labs around the clusters of production, construction, transportation, and communication, (4) develop a facility standard for facility planning and renovation, (5) replace old, large and single purpose equipment with computers and versatile equipment, (6) use self-instructional packets, lab modules, photo flip charts, CAI, wall charts, audiovisual techniques, and (7) provide assistance for optimum use of existing facilities in locales where economic conditions do not permit major overhaul of laboratories or equipment.

Concluding remarks

Technology education has been active throughout its history in meeting needs of students. The place and relevance of technology education in our schools for achieving the goal of technological literacy in the citizentry is beyond reasonable question. The issues, then, center around the extent to which this area of study can effectively provide a form of education designed for all citizens in a highly technological society. The shift of emphasis to technology education not only offers an opportunity for the field to grow, but also creates a new challenge that the profession needs to face. To take full advantage of this opportunity, will require efforts from the profession to make significant changes in updating programs and seeking support for these programs. More specifically, the technology education profession must direct its attention to the following:

1. Develop the ideal technology education curriculum model to ensure the technological literacy of all people.

The model proposed in this research can serve as the basic framework for further research and development. A field test of the curriculum model in some selected school districts must be carried out and evaluated before it is implemented nationally. The current major organizers of communication, transportation, manufacturing must be replaced or revised because they are not inclusive of technology. Curriculum resources should be expanded by providing consulting services, providing resources on computer applications, establishing a curriculum clearinghourse, providing a facility planning and renovating guide, and providing supportive videotapes.

2. Enhance the expertise of technology education teachers.

As the teaching content of technology education programs shifts to the emphasis of technology, so do the teacher education programs need to respond to this shift in emphasis. New teacher certification standards and National Teacher Examination should be upgraded to ensure the consistency in content and quality from one program to another. Experienced teachers need in-service education to upgrade their understanding of new technology and teaching strategies.

3. Establish relationship of technology education to related programs.

Technology education is the area in our schools in which a central and concerted effort is made to achieve technological literacy. Such technological literacy development must involve mathematics, science, social studies, economics, and environmental studies. Technological literacy can not be achieved through a narrow fragmented approach. The inclusion of multi-disciplinary activities in the study of technology should dictate the curriculum development. Teaching "how to" aspects of technology is the strongest contribution of technology education program to the study of technology, in contrast to "teaching about" technology without a laboratory in other curriculum areas. The interactions between the technology education and other curriculum subjects, especially science and mathematics need to be strengthened. Mathematics and scientific principles are used to explaine how technologies work, meanwhile, technology education content contributes to the understanding of mathematics, science, and other subject areas.

4. Develop computer-based technology education laboratory.

As computers have been invading almost every part of our society, university and schools are purchasing micro and mini computers at a remarkable rate primarily to teach computer literacy to students. Using computers as a medium of instruction has been shown to be effective in teaching and is increasing in popularity at schools. Computers have also been successfully used in industry to control machines, perform engineering design and analysis, monitor technical processes, manage productions, perform data procession, etc. Technology education laboratories need to use computers extensively. Computer-Aided Design, for example, should replace conventional drafting, computer numerical control machine tools substitutes outdated machine tools, tabletop publishing should be emphasized in communication course. In addition, robotics, laser technology, bar code inspection, and computer simulation techniques are items that need to be included in the contemporary technology education laboratories. Extensive use of computers in technology education labortaries will also improve the public image of this program. Consequently, the programs should gain more support from administrators, and parents, and become more attractive to students.

5. Improve public perception and support.

Building a positive public perception of technology education requires that technology education is seen as doing something that society values. The field needs to know what that is so it can publicize the ways in which it contributes to those values. Before seeking the ways to publicize the technology education programs, a strong, contemporary program should be established. A good program tens to publicize itself.

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ACKNOWLEDGEMENT

I wish to express my gratitude to those who have been helpful in assisting and providing valuable suggestions for this study. I am especially grateful to my major professor, Dr. William D. Wolansky, for his support, encouragement, and guidance.

I wish to express my sincere appreciation to Dr. Richard VanIten, Dr. Arthur Akers, Dr. Mack Shelley, and Professor Albert Sherick for their invaluable time and assistance.

Finally, I wish to thank my husband, Jonathon, for his encouragement during the time of my graduate career. I also need to extend my thanks to my two children, Andrew and Carol, for their cooperation making completion of this study possible.

APPENDIX A: COVER LETTER

College of Education
Department of Industrial
Education and Technology
Ames, Iowa 50011

IOWA STATE
UNIVERSITY

Telephone: 515-294-1033

Dear Department Chair: May 20, 1988

This research study is designed to ascertain the trends and issues of current technology education movement. Results of this study have the potential of assisting other industrial educators in understanding the strengths and weaknesses of industrial arts/technology education programs in the aspects of philosophical objectives, teaching contents, problems, solutions to the problems, and current status as well as prospects.

The enclosed instrument is divided into three parts. The first part contains items designed to gather information about your industrial arts/technology education teacher preparation program. The second part solicits your responses on a Likert-type scale to questions pertaining philosophical objectives, problems, and directions of the current technology education programs. The third part consists of thirteen questions concerning the prospects of technology education programs. It takes about fifteen minutes to complete this survey form. When you have completed the questionnaire, please staple and drop it in the mail. Your responses will be treated confidentially.

Your time and effort in completing this survey form is very appreciated. If you have comments or questions regarding this study, please feel free to use the space provided on the survey form. Again, thank you for participating in this research effort.

Sincerely,

Wm Wolansky

Hui-Chung Yang Lin
Graduate student
Industrial Education
& Technology

Dr. William Wolansky
Professor
Industrial Education
& Technology

APPENDIX B: FOLLOW-UP LETTER

College of Education
Department of Industrial
Education and Technology
Ames, Iowa 50011

IOWA STATE
UNIVERSITY

Telephone: 515-294-1033

JUNE 21, 1988

Dear Department Chair:

Recently you were sent a survey instrument requesting information about the current trends and issues of industrial arts/technology education programs. Your input will provide important and meaningful information for understanding and improving these programs. Hopefully, this reminder will emphasize our desire to hear from you.

We have enclosed another copy of instrument with this letter. We would appreciate it very much if you would fill out the questionnaire and return it to us as soon as possible. If you already have completed and mailed the questionnaire to us, please disregard this letter.

Thank you again for your time and cooperation in this effort.

Sincerely

Hui-Chung Yang Lin
Graduate Student
Industrial Education
& Technology

Wm Wolansky

Dr. William Wolansky
Professor
Industrial Education
& Technology

IOWA STATE UNIVERSITY

College of Education
Department of Industrial
Education and Technology
Ames, Iowa 50011

Telephone: 515-294-1033

March 8, 1989

Dear Department Chair:

Several months ago you were sent a survey instrument requesting information about the current trends and issues of industrial arts/ technology education programs at the college level. Your input will provide important and meaningful information for understanding and improving these programs. Hopefully, this reminder will emphasize our desire to hear from you.

We have enclosed another copy of instrument with this letter. We would appreciate it very much if you would fill out the survey form and return it to us as soon as possible. If you already have completed and mailed the questionnaire to us, please disregard this letter.

Thank you again for your time and cooperation in this effort.

Sincerely

Hui-Chung Yang Lin

Hui-Chung Grace Lin
Graduate Student
Industrial Education
& Technology

Wm Wolansky

Dr. William Wolansky
Professor
Industrial Education
& Technology

APPENDIX C: THE QUESTIONNAIRE

Technology Education Survey Form

Instructions: Please supply your best response or estimate. Complete every question to facilitate data analysis. The term "technology education" is used to abbreviate industrial arts/technology education in this survey form.

PART 1: Basic Data

1. What program does your department offer?
   - ____ technology education (TE)
   - ____ both technology education and industrial technology (IT)
   - ____ TE, IT, and Vocational/Technical education
   - ____ others (please specify) ______________________

2. What is the highest degree your department offers?
   - ____ Bachelor degree
   - ____ M.S., M.Ed., M.A., M.Eng.
   - ____ Ed.S.
   - ____ Ph.D., Ed.D., DIT
   - ____ others (please specify) ______________________

3. Compared to the 1981-82 school year, the enrollment of your department in 1986-87:

Technology education major	Industrial technology major
____ increased by ____ %	____ increased by ____ %
____ decreased by ____ %	____ decreased by ____ %
____ remained about the same	____ remained about the same

4. Indicate the percentage of technology education graduates' employment by categories:

	1981-82	1986-87
teaching	_____ %	_____ %
industry	_____ %	_____ %
self-employment	_____ %	_____ %

5. The average yearly starting salary of your technology education bachelor graduates in 1986-87:
   was ______ in thousands for teaching in schools.
   was ______ in thousands for working in industry.

6. Indicate the percentage of faculty with specialty areas in your department:
   - _____ % technology education
   - _____ % vocational/technical education
   - _____ % engineering
   - _____ % others (please specify)

7. Use the five-point Likert scales to indicate the curriculum emphasis of technology education teacher preparation program in your department during 1981-82 and 1986-87 school years, respectively.

1981-82 Most				Least		1986-87 Most				Least
5	4	3	2	1	professional education	5	4	3	2	1
5	4	3	2	1	electronics/computer	5	4	3	2	1
5	4	3	2	1	CAD/CAM/CIM	5	4	3	2	1
5	4	3	2	1	manufacturing	5	4	3	2	1
5	4	3	2	1	power/energy	5	4	3	2	1
5	4	3	2	1	graphic communication	5	4	3	2	1
5	4	3	2	1	construction	5	4	3	2	1
5	4	3	2	1	specify:____________	5	4	3	2	1
5	4	3	2	1	specify:____________	5	4	3	2	1

8. Use the five-point Likert scales to indicate how significantly the following technologies impact your programs and how well your department adapts these technologies into the existing curriculum.

Impact of technologies on your program: Most				Least		Adaptation of technologies to your program: Most				Least
5	4	3	2	1	computer	5	4	3	2	1
5	4	3	2	1	digital electronics	5	4	3	2	1
5	4	3	2	1	NC/CNC	5	4	3	2	1
5	4	3	2	1	robotics	5	4	3	2	1
5	4	3	2	1	CAD	5	4	3	2	1
5	4	3	2	1	CAM	5	4	3	2	1
5	4	3	2	1	laser	5	4	3	2	1
5	4	3	2	1	tabletop publishing	5	4	3	2	1
5	4	3	2	1	specify:____________	5	4	3	2	1
5	4	3	2	1	specify:____________	5	4	3	2	1

PART 2: Objectives, Problems, and Directions of Technology Education

Please respond to the following questions concerning the objectives, problems, and possible directions of current technology education programs.

A. Objective

The missions of technology education are to:	Strongly agree				Strongly disagree
1. Develop an understanding of the nature and characteristics of technology.	5	4	3	2	1
2. Develop basic skills in the use of common tools and machines.	5	4	3	2	1
3. Develop consumer knowledge and appreciation of industrial products.	5	4	3	2	1
4. Develop safe working practices.	5	4	3	2	1
5. Develop recreational and avocational interests.	5	4	3	2	1
6. Discover and develop creative technical talents in students.	5	4	3	2	1
7. Provide pre-vocational experiences.	5	4	3	2	1
8. Provide vocational training.	5	4	3	2	1
9. Develop problem-solving and decision-making skills involving human, material sources, processes, and technological systems.	5	4	3	2	1
10. Provide opportunities to identify aptitudes, abilities, and interest meaningful to career selection.	5	4	3	2	1
11. Provide opportunities for reinforcement of content learned in other subject areas.	5	4	3	2	1
12. Interpret the evolution and relationships of society, industry, and technical means.	5	4	3	2	1
13. Establish beliefs and values based upon the impact of technology and how it alters environments.	5	4	3	2	1
14. Prepare individuals for intelligent participation as informed citizens in a technological society.	5	4	3	2	1
15. Prepare student for lifelong learning in a technological society.	5	4	3	2	1
16. Make all students technologically literate, principally as consumers rather than as producers.	5	4	3	2	1
17. Enable individuals to better control their own and society's destiny.	5	4	3	2	1

B. Problem

Teacher Factors	Strongly agree				Strongly disagree
1. The secondary schools will face a serious shortage of qualified teachers during the coming decade.	5	4	3	2	1
2. The majority of graduates from TE teacher preparation programs go into industry.	5	4	3	2	1
3. More TE teacher preparation programs will be eliminated from colleges/ universities within the coming decade.	5	4	3	2	1
4. University administrators do not understand adequately the purpose of TE teacher education.	5	4	3	2	1
5. TE teacher preparation programs will face serious competion for student sources with industrial technology programs.	5	4	3	2	1
6. TE teacher preparation programs will experience a dramatic enrollment decline.	5	4	3	2	1
7. A high percentage of TE teachers will leave teaching for industry positions.	5	4	3	2	1
8. TE teacher preparation programs continue to lack effective recruitment strategies.	5	4	3	2	1
9. TE teachers lack administrative support on their campuses.	5	4	3	2	1
Others: specify ____________	5	4	3	2	1
specify ____________	5	4	3	2	1

Enrollment Factors	Strongly agree				Strongly disagree
10. The emphasis of back-to-basic movement leaves no room for elective subjects to include TE courses in secondary schools.	5	4	3	2	1
11. The shortage of qualified teachers casues the closing of many TE programs in the secondary schools.	5	4	3	2	1
12. TE curriculum is not a part of the mandatory courses in the secondary school.	5	4	3	2	1
13. School administrators do not understand TE courses adequately.	5	4	3	2	1
14. Parents do not understand TE courses.	5	4	3	2	1
15. TE programs lack an effective student recruitment strategies.	5	4	3	2	1
16. There is a sharp drop in school population.	5	4	3	2	1

Teaching Content Factors	Strongly agree				Strongly disagree
17. TE programs lack a recognized body of knowledge and has no well-defined content base.	5	4	3	2	1
18. The scope of content represented in all teaching areas can not be included in a given curriculum.	5	4	3	2	1
19. There is a marked difference between the implied scope of knowledge and study and the actual activity and results due to facility and time constraints.	5	4	3	2	1
20. TE programs lack a rational basis for selecting specific technological categories.	5	4	3	2	1

Facility Factors					
21. TE programs lack adequate facilities and equipment to reflect ongoing technological change to stay current.	5	4	3	2	1
22. TE programs lack standard facilities to support a wider variety of technological activities.	5	4	3	2	1

C. Directions

Teacher Factors	Strongly agree				Strongly disagree
There exist needs to:					
1. Upgrade TE teacher education programs.	5	4	3	2	1
2. Develop an effective perspective teacher recruitment strategy involving TE teacher, guidance counselor, and university faculty.	5	4	3	2	1
3. Develop a comprehensive public information campaign involving all agencies, associations, media, and which would be geared to the general public as well as to secondary students and teachers.	5	4	3	2	1
4. Aim recruitment efforts at all age levels of students.	5	4	3	2	1
5. Recruit perspective teachers from minority and woman populations.	5	4	3	2	1
6. Provide in-service training for TE teachers.	5	4	3	2	1
7. Expand and include a wide variety of technological processes for all prospective TE teachers.	5	4	3	2	1

	Strongly agree				Strongly disagree
8. Aid prospective TE teachers by enabling them to understand the potential sociological, economic, aesthetic, environmental, ethical, and political effects of technological change so that these could be illustrated clearly to future students.	5	4	3	2	1

<u>Enrollment Factors</u>

There is a need to:	Strongly agree				Strongly disagree
9. Develop a form of quality technology education appropriate for the whole range of school population.	5	4	3	2	1
10. Move away from a craft dominated program to one that centers on technology education and is attractive to all students.	5	4	3	2	1
11. Improve public awareness and support.	5	4	3	2	1
12. Recruit more female students.	5	4	3	2	1
13. Draw support of parents, teachers, counselors, and other adult figures who might influence student opinion.	5	4	3	2	1
14. Recruit student leaders, talented and gifted students, and athletes.	5	4	3	2	1
15. Improve the ambiance of facilities such as laboratory ventilation and brightness and safety.	5	4	3	2	1
16. Develop relationships within school aimed at a broader involvement of the other disciplines.	5	4	3	2	1
17. Establish relationships with the community beyond the school where understanding and support must be achieved.	5	4	3	2	1

<u>Teaching Content Factors</u>

There is a need to:	Strongly agree				Strongly disagree
18. Redefine the content, programs, and practices so that they will reflect the contemporary and future concepts of technology education.	5	4	3	2	1
19. Develop and improve model technology education programs.	5	4	3	2	1
20. Research and develop new/improved instructional delivery systems.	5	4	3	2	1
21. Expand curriculum resources.	5	4	3	2	1
22. Develop a form of TE that will have a strong experiential base wherein the theory and practice come together to provide increased understanding and meaningful involvement with technology.	5	4	3	2	1

<u>Facility Factors</u>	Strongly agree				Strongly disagree
There is a need to:					
23. Modify the existing unit-shop to teach a technology based general lab.	5	4	3	2	1
24. Orient the TE labs around the clusters of production, construction, transpo-rtation, and communication.	5	4	3	2	1
25. Develop a facility standard for faci-lity planning and renovation.	5	4	3	2	1
26. Replace old, large and single purpose equipment with computer, and versatile equipment.	5	4	3	2	1
27. Develop a total facility and curricu-lum plan to teach a technology based program.	5	4	3	2	1
28. Provide assistance for optimum use of existing facilities in locales where economic conditions do not permit major overhaul of laboratories or equipment.	5	4	3	2	1

PART 3: Prospect of Technology Education

Please respond to the following questions concerning the prospects of technology education by circling the number on the Likert-type scale that represents your best answer.

Within the next ten years:	Strongly agree				Strongly disagree
1. Enrollment in TE teacher education programs will increase significantly.	5	4	3	2	1
2. Job opportunities for graduates from TE teacher programs will remain strong.	5	4	3	2	1
3. The TE teachers' starting salary will remain competitive.	5	4	3	2	1
4. The image of TE teacher education programs will get better.	5	4	3	2	1
5. The number of TE faculty in colleges/universities will grow.	5	4	3	2	1
6. Quality of TE teacher in secondary schools will improve.	5	4	3	2	1
7. Enrollment of TE programs in secondary schools will increase.	5	4	3	2	1
8. Administrators' support for TE programs in secondary schools will grow.	5	4	3	2	1
9. Image of TE programs in secondary will improve.	5	4	3	2	1
10. The scope of content will reflect the concepts of technology education.	5	4	3	2	1
11. A well-defined curriculum standard will be available and widely adopted.	5	4	3	2	1
12. Equipment acquisition for TE programs will be well funded in the secondary schools.	5	4	3	2	1
13. A well-defined facility standard will be available and widely adopted.	5	4	3	2	1

THANK YOU FOR YOUR TIME AND EFFORT